

ACCESS CONTROL FOR
LOCAL ROADS AND STREETS
IN SMALL CITIES
AND
RURAL AREAS

BY
Hussein F. Dia
And
Jon D. Fricker

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PREFACE

This manual, "Access Control for Local Roads and Streets", is a response to the need expressed by local public officials in small cities and rural areas for a single reference book on the subject. The authors of this manual have gathered information on access control from numerous sources, reviewed this information for consistency and conformance to basic traffic engineering principles, and sought to ensure its applicability to the smaller municipalities and the developing rural areas in Indiana. There is an adequate body of literature on access control, but these research findings and recommended practices have not been easily accessible to local public officials in a form compatible with their particular needs.

This is a technology transfer activity. A variety of scattered references have been combined into a single volume with small communities in mind. There is always the danger of prescribing a solution to a hypothetical problem or transferring a solution that worked in another locality. Accordingly, this manual can only provide a good starting point for sound engineering analysis -- it can't replace it. On a given topic, this manual is designed to present the relevant general principles for the reader's consideration. Whenever possible, numerical guidelines are offered, but they are only that -- guidelines, not standards or requirements. Special local conditions and peculiarities must be taken into account during the analysis. This manual can only provide the framework for the analysis. There is no substitute for observation, evaluation of alternatives, and adequate documentation of the process.

Portions of this manual have been reviewed by William D. Fife, Street Commissioner, City of Lafayette; J. William Strange, then Highway Engineer, Hancock County; James C. Taylor, Town Manager, Town of North Manchester; and Thomas Ford, Division of Traffic, Indiana Department of Highways. The authors thank these gentlemen for their assistance and helpful comments.

The authors hope that this manual will be of value to street commissioners, road supervisors, and city and county engineers throughout Indiana. We welcome your comments and suggestions on how to improve the manual.

Jon D. Fricker
Hussein F. Y. Dia

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1. INTRODUCTION

Any complete street or highway system must provide the functions of both land access and traffic movement, which are necessary but generally conflicting functions. Excessive roadside development and uncontrolled driveway connections precludes the orderly, and safe movement of traffic in and out of private properties, and therefore, results in poor levels of service, increased hazards, and early obsolescence of the highway. This leaves the authorities responsible for the street or highway with the challenge of providing adequate access to abutting properties while not sacrificing traffic operations along the route.

The rights of abutting property owners for access are acknowledged, but it is necessary for the responsible authority to establish controls regarding the number, location and geometrics of access points. This is necessary to maintain good operational characteristics on the facility and to provide adequate safety features for the expeditious movement of people and goods.

As travel demand and adjacent land use increase in the developing urban fringes, highways deteriorate in their ability to accommodate traffic safely and efficiently. At first the new developments were regarded as a means of balancing suburban growth and expanding the local tax base. Some were well planned with respect to roadway access, but for the most part, they have reduced the efficiency of the street and roadway systems. Studies in different parts of the country show that the number of potential conflict points among vehicles rises as a result of an increasing number of driveways, which in turn generally increases the accident rates. The streets and highways constitute an important resource and a major public investment. It is therefore essential to operate them efficiently. A well conceived, comprehensive access management program can save time and lives; more importantly, it can help maximize the capacity of the highway and preserve access to surrounding activities. The lack of a well-defined policy can increase hazards and lead to driveways that make it difficult to enter and leave adjoining developments.

Traffic and transportation engineers have been involved in refining many methods for improving flow along roadways, rural highways and expressways over the past three decades. They have shown that coordinated roadway design and traffic operations can increase capacity, reduce delays and cut accidents. They have shown how curb parking restrictions, turn lanes, and intersection channelization combined with good geometric designs can work together to achieve these objectives. But these operational techniques alone can do very little when confronted with poorly located or planned

access to adjoining land, and they certainly cannot always accommodate the large increases in traffic superimposed on existing roadways by major developments that are placed without regard to the traffic characteristics of the surrounding roads. It is obvious then that there is an urgent need for traffic management and access control program that would preserve the highway safety and capacity, reduce delays and allow for the commercial and industrial growth in accordance with a well developed plan, as an alternative to the more costly, time-consuming and socially disruptive roadway construction or relocation. Access management thus should extend traffic engineering principles to the location, design, and operation of access driveways serving activities along the highway. It is in many aspects an effective application of Transportation System Management. It is where the traffic engineer, town planner and developer can work together.

This handbook is a collection of both published and unpublished material from prior studies, the primary objective of which is to establish guidelines for the design and location of driveways providing access from public streets and highways to developments on abutting property. It is important to mention here that in order for the guidelines to be of maximum value, wide flexibility should be retained in their application, and engineering judgement should override recommended dimensions if warranted by specific traffic conditions.

2. PROGRAM ELEMENTS

If the objectives mentioned in the Introduction are to be achieved effectively, the Access Management Program must include the following elements [19]:

- I. Technical: A set of guidelines should be set for managing access through design and operation; use of islands, turning lanes; radius and driveway requirements. The guidelines should establish ways to coordinate internal and external access plans.
- II. Legislation: These are the laws relative to access control, access permits, site plan guidelines, financial permits and zoning requirements.
- III. Enforcement: These are procedures for monitoring adherence to regulations and taking action against violators.
- IV. Coordination among agencies: Coordination between city and state, or among traffic, planning, engineering, and police in a community, must be established and agreed upon by the respective agencies.

Thus, access management views the highway and its surrounding activities as part of a single system, where the goal is to coordinate the planning and design of each element so as to preserve the capacity of the overall road system, and to allow efficient access to and from the activities along it.

In planning access for a development, it is important to evaluate the effects of the access on the highway and its surrounding activities.

Major considerations are:

1. What is the nature of the development and what traffic volumes will it generate?
2. Where will the access be located and how will it relate to the street system?
3. How will the existing street system accommodate the added traffic generated by the development and what access changes, if any, are desirable or essential to help maximize the capacity of the adjoining streets?

It is important that the effects of access be evaluated not only for the proposed development, but also for other

likely nearby developments. Coordination between the different agencies responsible for the traffic, planning and engineering in the community can thus have a positive influence on the final access decisions.

3. ANALYSIS STEPS

The following types of information are needed to reach appropriate traffic and development decisions [19]:

1. Characteristics of the existing roadway and public transport systems. Parking practices, roadway widths, daily and peak hour traffic volumes (preferably by direction), rights of way, travel times and delays, signal locations, bus service routes and frequencies.
2. Characteristics of proposed developments. Their type, size, location with respect to nearest access points and parking space provisions.
3. Future development traffic. Parking space requirements; the peak-traffic hours, the peak-hours of the specific development, and the number of vehicles that will enter and leave the site and their directions.
4. Composite traffic on surrounding and approach roads. Adding development traffic to highway traffic for the year the developments are opened. These estimates should be realistic so that demand understating or overstating is avoided.
5. Road system adequacy and needs. The ability of the roadway system to carry the anticipated traffic should be analyzed, and improvements outlined. This task involves comparing future volumes with present and future capacities.
6. Access plan. Identifying the needed access changes along the adjoining roads, coordinated with the drive-ways leading to and from the site, and the internal site plan.
7. Financial responsibilities. Developers, communities, and the state must arrange and agree upon the timing and cost of the proposed improvements.

The general sequence of site access decisions is [19]:

- i. Should the access points be modified or prohibited?
- ii. Should the size of the development be reduced, or type of development changed?
- iii. Should the development be deferred until the needed roadway improvements are finished, or be prohibited because of its adverse impact?

As for access points, major options and issues involved are [19]:

- a. Can full access be provided between the roadway and the development?
- b. Should the access be restricted to right turns into and out of the given development?
- c. Should the access points be relocated so that they would line up with the existing access to the developments on opposite sides of the street or relocated away from intersections?
- d. Should the access points be spread to separate conflicting left turns into and out of the site, and what are the criteria to be considered in such circumstances?
- e. Should access points be prohibited along major streets and allowed only along secondary streets?

It should be pointed out here that the objective is to assure that the developments can be effectively managed from a transportation perspective. Limiting the new developments is not really our concern, although such an action may sometimes be imposed. The techniques applied are simple and straightforward. They include better control of conflict points, separation of turning and through traffic, and coordination of access points with both the roadway system and the internal circulation system.

4. CLASSIFICATION AND DEFINITIONS

The following definitions deal with the various types of roads and areas as used in this handbook [15]:

4.1 Areas

These are classified into Urban and Rural. An area is defined as Urban if the abutting street has a speed limit of 40 mph or less, or if at least 50 percent of the frontage on one side of the route within one half mile of the proposed driveway location has been developed with residence, business and/or industry. The term Urban also includes developed areas within incorporated limits of municipalities and urbanized townships or counties.

All areas not subject to the above definition are considered Rural.

4.2 Roads

4.2.1 Major Route. The term Major Route includes all marked county, state or federal routes and all urban streets:

- i. Having continuity. Route continuity refers to the provision of a directional path along the length of the route so that the driving task is simplified. Route continuity is an extension of the principle of operational uniformity combined with the application of proper lane balance [4].
- ii. Accommodating a minimum amount of 3,000 vpd of through traffic.
- iii. On which traffic is assigned the right-of-way by stop signs facing cross streets.

Others [9,13] classify roads with respect to the amount of traffic volumes they accommodate:

4.2.2 Low Volume. Accommodating volumes between 0 and 5,000 vpd, with an average of 3,000 vpd.

4.2.3 Medium Volume. Accommodating volumes between 5,001 and 15,000 vpd, with an average of 10,000 vpd.

4.2.4 High Volume. Accommodating volumes greater than 15,000 vpd, with an average of 20,000 vpd.

4.3 Land Uses

Areas of low pedestrian activity include most Urban residential neighborhood business and industrial streets. Areas of high pedestrian activity include those streets through central business districts as well as those in the same block with schools, libraries and secondary (community type) business districts. Streets and highways adjacent to public parks and rapid transit stations may also fall into this category.

A development can fall into one of the following groups [18]:

4.3.1 Low level. The number of driveways per mile is between 0 and 30, with an average of 15.

4.3.2 Medium Level. The number of driveways per mile is between 31 and 60, with an average of 45.

4.3.3 High Level. The number of driveways per mile exceeds 60, with an average of 75.

4.4 Driveway Types

Driveways generally fall into one of the following three categories:

4.4.1 Residential. A residential driveway is one that provides access to a single family residence, a duplex, or an apartment building containing five or fewer dwelling units.

4.4.2 Commercial. A commercial driveway is one that provides access to an office, retail, industrial building or an apartment building having more than five units.

4.4.3 Industrial. An industrial driveway is one that serves mainly large number of trucks in industrial plants or truck terminals. Such facilities are usually served by two types of driveways; one specially designed, signed and located to provide access for trucks (Industrial Driveway) and the other serves administrative and employee parking lots (Commercial Driveway).

Others [13,18] classify driveways with respect to the amount of traffic volume a driveway is expected to accommodate. These categories are:

4.4.4 Minor Driveways

4.4.4.1 Minimum Use. These are driveways with nearly negligible traffic volumes, i.e. residential driveways.

4.4.4.2 Low Volume. Driveways with traffic volumes less than 500 vpd (average 250 vpd), e.g. serving 100-room motel.

4.4.4.3 Medium Volume. Driveways with volumes between 500 vpd and 1500 vpd (average 1000 vpd), e.g. serving a drive-in restaurant.

4.4.5 Major Driveways

These are driveways accommodating high volume traffic, i.e. over 1500 vpd (average 2000 vpd), e.g. serving a regional shopping center.

5. DESIGN CONSIDERATIONS

In order to minimize accidents and to assure best overall use of the road facility by the general public, it is necessary to regulate vehicle movements into and out of adjoining developments. It has been mentioned that conflicts often arise when trying to accommodate the road users rights for access to abutting property as well as the right to safe movement on the highways and streets. The responsible authorities, cities, counties or states having jurisdiction over public thoroughfares are generally given the responsibility of reconciling, and to the extent feasible, satisfying the needs and rights of all road users with respect to the design, location and operation of the driveways. It should be mentioned here that if conflicts cannot be fully resolved, preference should be given to the safe and efficient use of the highway.

The following are some design considerations on which recommended practice is based [15]:

1. Driveways are not special concessions to land owners; they represent a service to the general public.
2. Conflicts at driveways are a function of traffic flow along the street, at the driveway, from adjacent driveways and from driveways on the opposite side of the road.
3. A low volume driveway causes relatively little conflict on a major route, and a high volume driveway causes little conflict on a minor route. The relationships, however, are not necessarily linear.
4. Driveways are considered as "T" intersections. The volume of traffic at a driveway, however, can be greater than that of most intersections of local streets with major routes, and is a function of the land use activity to which the driveway is furnished.
5. The design elements of a driveway (location, spacing, sight distance, throat width, radii, angles, deceleration and acceleration lanes, and grades (see Chapter 9) should be based on expected volumes by directions of arrival and by vehicle characteristics.
6. The left turn entry movement generally produces the greatest hazard and congestion on the street. This effect could be reduced by introducing a separate left turn lane.
7. The left turn exit movements are relatively hazardous and the right turn entry movements cause traffic

impedance. Allowance for these movements should take into account the spacing of the driveway relative to the closest traffic control (especially a signal) along the street.

8. Driveways along major routes should be designed for curb lane access and with minimal encroachment on travel lanes. In order to avoid encroachment on travel lanes, radii for right turn entry and exit should be consistent with the design vehicle's swept path requirements as described in [4]. If the radius is inadequate, the throat of the driveway must be increased so as to accommodate a substantial length of the vehicle, so that encroachment could be precluded.
9. It is acceptable for vehicles to sweep across the entire throat if the driveway is one-way, or of low volume.
10. Two-way driveways are the most practical design for many conditions. Such driveways should be separated by a center line if they are to accommodate high volumes.
11. In most cases, pedestrian accidents at driveways are negligible compared to the number of vehicular collisions involving driveways. Where pedestrian safety is a major factor, the design of the driveway should take into account the width of the driveway and the placement of the sidewalk within the area between the curb and the property line. A larger width reduces the number of vehicular delays and conflicts at the driveway, but increases pedestrian hazard. This indicates that two separate design standards are needed in urban areas: one to minimize the pedestrian-vehicle conflict and the other to minimize the vehicle-vehicle conflict.
12. Secondary routes carry lower volumes of traffic, and thus less stringent requirements are used for their design. Rural highways, however, with much higher speeds than urban streets, require a higher level of design.
13. The driveway design elements cited above are directly related to the layout of the parking area, amount of reservoir space (for drive-in-service facilities), type of loading facility, circulation pattern and building placement within the site.
14. Collaboration between the departments responsible for building and driveway permits is highly recommended at all stages, since the site plan and driveway design are critically related.

15. Any zoning changes should consider the driveway access elements. An estimate of the traffic volumes expected to be generated by a new development must be arrived at so that the access driveway could be designed accordingly.
16. Since no one set of regulations can be expected to apply to all access requirements, guidelines should be subject to administrative variations based on justified engineering judgment.

Figure 5.1 is an illustration of the required design considerations and coordination.

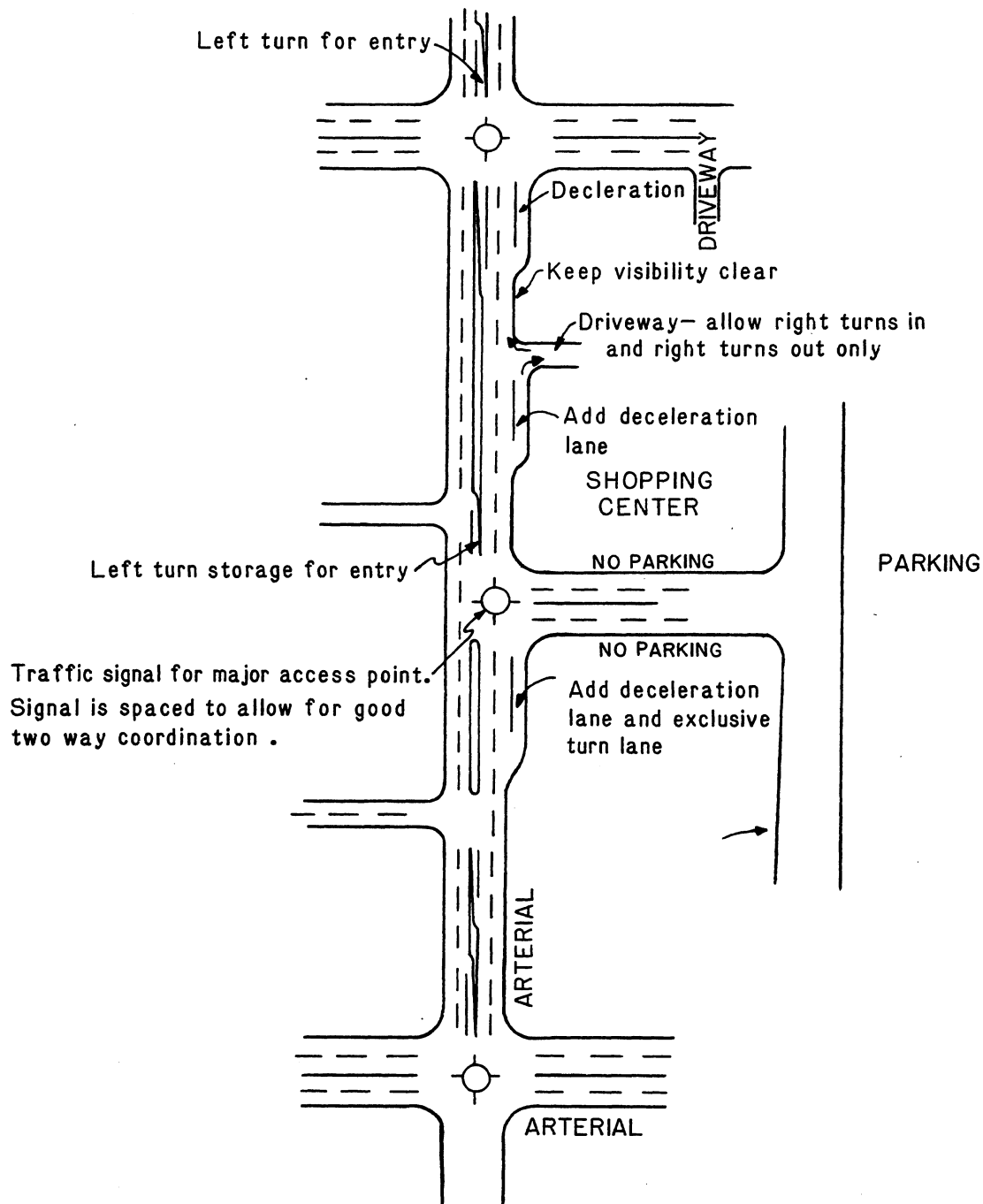


FIGURE 5.1 [18] DESIGN COORDINATION

6. ESTIMATING DRIVEWAY TRAFFIC

The typical steps involved in making volume projections for individual access points of a proposed development could be summarized as follows [15]:

1. Identify the important characteristics of the land development as related to traffic conditions during the critical hour(s).
2. Select an existing project with similar characteristics as the proposed development's. Take counts of the turning movements and calculate the generation rate in terms of an appropriate unit. If similar projects are not available for study, data from other projects or previous studies, with similar characteristics as the proposed development's could be updated and used.
3. Calculate the in-bound and out-bound volumes for the peak hour(s) for the proposed land use as in [15].
4. Estimate directional splits and calculate turning movements. For example, consider a suburban area located to the south of Indianapolis, where the majority of the people have to travel daily to their jobs in the city. It is logical to postulate that 80-90 percent of PM peak hour traffic would be southbound, and a similar directional split would be expected northbound for the AM peak hour traffic.
5. Assign appropriate volumes to individual access points. Referring to the above example again, consider an apartment complex in the suburban area with 400 dwelling units. Assume that volumes of 150 vehicles inbound and 60 vehicles outbound during the PM rush hour were calculated in step 3 for this development, and that the development has two access points. Considering that drivers tend to use the closest access point [15], the driveway further to the north could be assigned a value of 110 vehicles inbound, and the other 40 vehicles inbound.
6. Evaluate the potential conflicts with street traffic, particularly as related to left turn entering and leaving movements. Assess the need for roadway improvements adjacent to and downstream from the site, such as the addition of a new turning lane, etc.

Thus, the traffic effect of the new development could be appraised, and knowledge of the probable traffic volumes is used in choosing driveway locations and in preparing designs. It should be noted here that right-of-way dedications and payment for street

improvements are best negotiated before rezoning or granting a building permit.

7. ACCESS CONTROL DESIGN ELEMENTS

In the next three sections, we will discuss the elements of driveway design as related to the recommended practice.

The techniques used for access control require the sensitive and sensible applications of established traffic engineering and roadway design principles. These techniques serve the following objectives [13]:

1. Limit the number of conflict points.
2. Separate basic conflict areas.
3. Reduce deceleration requirements at entrance points.
4. Remove turning vehicles from through lanes.

These techniques are applied to the components of access control, which are (Figure 7.1):

- i. The roadway
- ii. The access point, i.e., the driveway
- iii. The site or the development itself

It is important that these techniques be applied to the three components of access control in a coordinated way. These elements must be considered as part of a single overall plan, since neglecting one of them would merely transfer rather than solve the problem.

The discussion that follows sets forth the criteria for planning and designing roadways, driveways and on-site circulation [11,12,13,15,16,17,18,19,23,30].

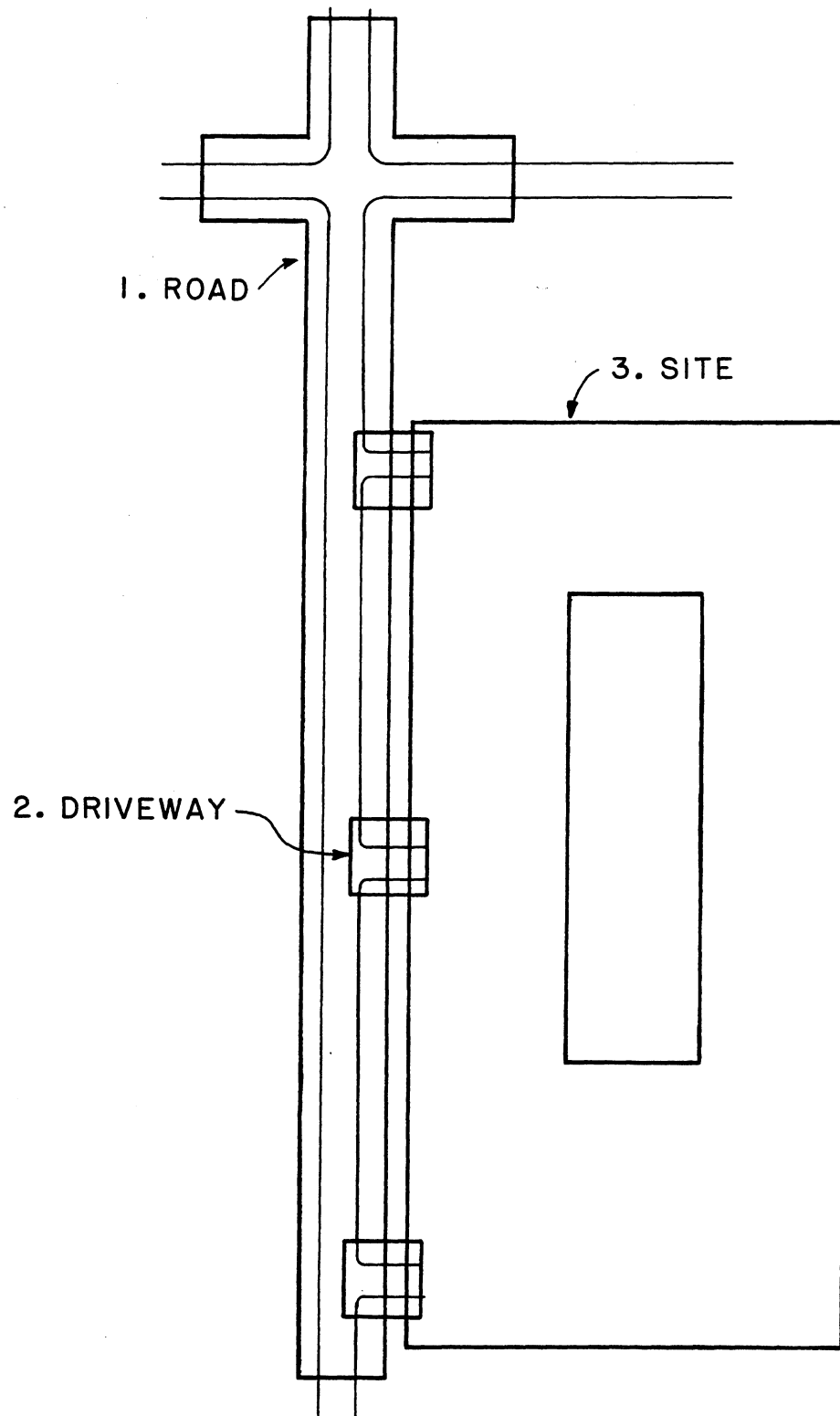


FIGURE 7.1 [9]: THE THREE COMPONENTS
OF ACCESS CONTROL

8. THE ROADWAY

The design of roadways serving adjoining commercial developments must maintain the operational integrity of the roadway for general traffic flow, while simultaneously providing access to adjacent developments. For major developments, this is usually accomplished by expanding the capacity of the roadway. For smaller developments, this is accomplished by careful driveway control. It is recognized that allowing an unlimited number of driveways along roads, especially in suburban areas, results in poor traffic operations in terms of safety and travel times. Thus, the challenge is where to allow access and how to design it.

8.1 Median Access Control

Median access control limits movement of left-turning and cross traffic through the design and spacing of median openings and left turn lanes.

As noted previously, the primary objective of a major route is to serve traffic, rather than to provide access to abutting property. Direct left turns on a route, i.e., where the left turn movements are not provided through left-turn lanes or other regulatory measures, can present serious safety and operational problems. Roadway capacity can also be seriously affected by even a small number of left turning vehicles if adequate median left-turn storage is not provided.

Safe and efficient operation could be promoted by minimizing the frequency and severity of traffic conflicts:

1. Limit the number of conflict points.
2. Separate basic conflict areas.
3. Reduce maximum deceleration requirements.
4. Remove turning vehicles or queues for certain portions of the through lanes, by introducing separate turn lanes or some other regulatory measure.

There are many Median Access Control strategies that can be used effectively in reducing access point conflicts. These are discussed in the next section. Other special design options should be considered carefully in relation to the specific traffic conditions.

In his studies in Skokie, Illinois, Box [7] found that 70 percent of all driveway accidents involved vehicles turning left, into or from a driveway. Similar studies in

Indiana by Uckottor [26], found that left turn movements were involved in 63% of all driveway accidents. Thus, left turn treatment will be discussed first.

8.2 Median Types

A median is defined as the strip of land between opposing lanes of a highway. Medians can be used to decelerate and store left-turning and U-turning traffic, restrict undesirable movements, protect crossing traffic, and separate opposing streams of traffic. AASHTO's recommendations are that a median designed for left-turn storage should be 16 to 18 feet wide, with a minimum width of 14 feet. (Table A.4 in Appendix A also provides dimensions based on the function of medians). It should be noted that the type of vehicles designed for is a factor in this determination. A median can be placed into one of the following two groups:

A. Traversable (painted) medians:

1. Two-way left turn lane
2. Continuous left turn lane
3. Alternating left turn Lane

B. Barrier Median:

Curbed medians and intersection channelization were found to have the following advantages [14]:

1. Smooths and enhances the highway free-flow traffic carrying ability.
2. Decreases conflicts by providing a positive separation of opposing lanes of traffic.
3. Permits the regulation of traffic through the prohibition of certain movements.
4. Provides a protection and storage area for heavy vehicle directional movements from opposing traffic.
5. Provides opportunity to favor a predominant movement.
6. Gives better indication to motorists of the proper use of travel lanes and intersections.
7. Provides protected areas for the location of traffic control devices.

8. Controls the speed of turning vehicles through the intersection area.
9. Serves as a protected refuge area for pedestrians.

The following are the barrier median options:

1. Barrier median with left-turn Lanes.
2. Barrier Median with no direct left-turn Access.

The purpose of left-turn lanes is to provide storage space and to provide for deceleration out of the through lanes. At signalized median openings, the lane should store a minimum of 1.5 times the average arrival rate (vehicle per minute), allowing 25 feet per vehicle. At unsignalized median openings, the lane should store a minimum of 2.0 times the expected arrivals in one minute [30].

Left-turn lanes should be a minimum of 10 feet wide, with a desirable width of 12 feet. Barrier medians 16 to 18 feet wide allow development of a left-turn lane with adjacent separator. Desirable separator width is 6 feet, with a minimum of 4 feet.

The following is a discussion of the above median types.

8.2.1 Two-Way Left-Turn Lane. Two-way left-turn lanes are becoming increasingly popular throughout the U.S. This is mainly attributed to the fact that this median type treatment is the least restrictive, because it allows left-turns at all points, and removes left-turning vehicles from the through traffic.

This technique is highly cost-effective in providing left-turn storage for undivided roadways, especially where there are many low-volume {4.4.4.2}, nonsignalized driveways along both sides of the road. Its major design requirement is a center lane that is 16-18 feet wide, with a minimum of 14 feet and a maximum of 19 feet. Widths of greater than 19 feet may create driver confusion and misuse. The addition of this type lane to an undivided roadway can greatly reduce accidents. This design is particularly effective in locations with strip commercial development and frequent (closely spaced) driveway openings experiencing moderate left turn demand (about 20 percent of through volume during peak travel periods) and when the road volume exceeds 10,000 vpd and the road speed exceeds 30 mph.

Locations with high accident rates resulting from left turn movements also warrant this technique. A 35 percent reduction in accident rate can be expected [18].

However, the selection of this design for a section with concentrated left turns (greater than 40 percent of through volume during peak periods) may not be advisable, since this will reduce the two-way left-turn lane to a one directional left-turn lane. At major driveways {4.4.5}, and at signalized intersections, barrier median with left-turn lanes or alternating left-turn lanes should be provided.

Consideration should be given to adequately separate or to align entrances and exits to major generators on opposite sides of the street, so that the areas of opposing traffic are separated. The two-way left-turn lanes should be marked as shown in the Manual on Uniform Traffic Control Devices [20,21]. Figure 8.1 is adapted from these references.

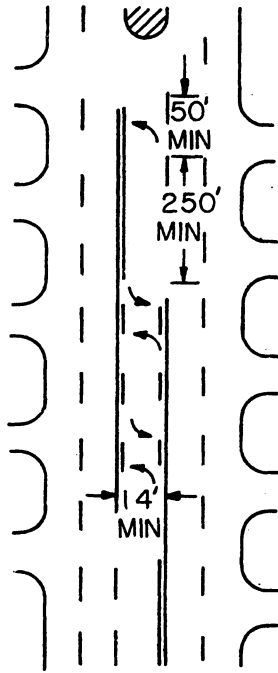


FIGURE 8.1 [18] TWO-WAY LEFT TURN LANE

8.2.2 Continuous Left-Turn Lane. This median treatment provides adjacent separate left-turn lanes for each direction of travel. Desirable width is 12 feet per lane, or a 24-foot traversable median. Standard treatment is to convert to a single one-way left turn lane at major intersections [15].

Left turn storage and access is provided for both sides of the highway at every point. The continuous left-turn lane has more storage than the two-way left-turn lane and eliminates the potential for head-on conflict in the storage area. The drawbacks for this option are that the left-turning vehicles must cross the opposing left-turn lane, in addition to the opposing through lanes; and that a greater median width is required than for the two-way left-turn lane. Standard striping of this median design are found in the 1971 Manual on Uniform Traffic Control Devices [20,21] adapted in Figure 8.2.

8.2.3 Alternating Left-Turn Lane. This option divides a traversable median into exclusive left-turn lanes, providing left-turn access for first one direction of travel and then the other into closely spaced driveways. This type of design has the advantage of requiring a center lane only 10-12 feet wide versus the usual 14 feet. This technique is appropriate where there are concentrated left turn locations, exceeding 15 percent of through traffic during peak traffic demand, or where traffic volumes exceed 10,000 vpd and speeds exceed 30 mph, or where warranted by accident rates resulting from left-turn movements.

This technique should reduce accidents by 25 percent [18], but it should only be used when other left-turn techniques are not feasible, since it is somewhat restrictive in that left-turn storage is not provided for both directions at all points. Left turns into minor side streets or driveways might not be provided for, and would cause confusion. Another drawback of this option is that turning across the double yellow line is permissible at any point without crosshatching, and left turning from the through lanes may occur, if there are access points not served by the left-turn lane. Traversable medians are not effective by nature as access control devices, although they do serve the function of reducing left-turn conflicts by providing left-turn storage. Refer to Figure 8.3 for illustration.

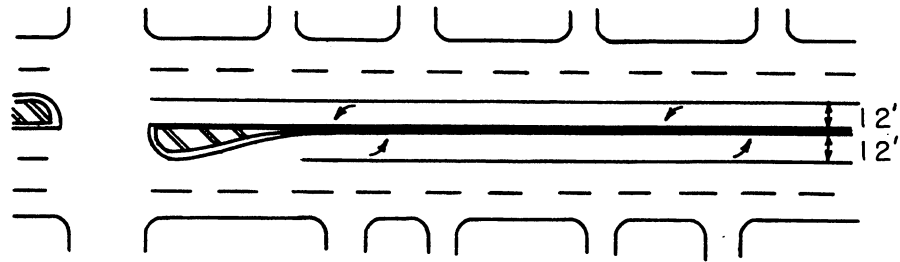


FIGURE 8.2 [30] CONTINUOUS LEFT TURN LANE

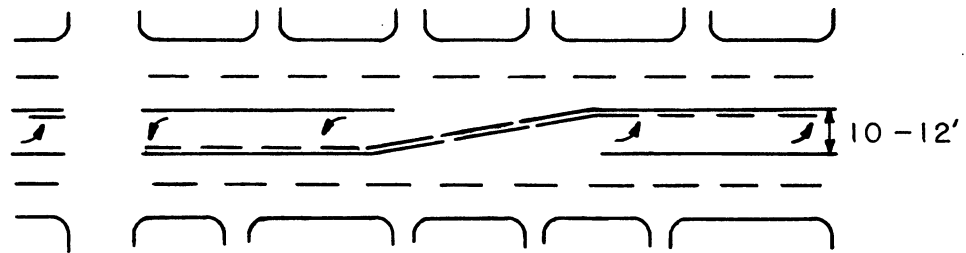


FIGURE 8.3 [30]
ALTERNATING LEFT TURN LANE

8.2.4 Barrier Median With Left-Turn Deceleration Lanes. This median treatment controls access by permitting left-turns and crossing movement at major driveways. Barrier medians physically separate traffic traveling in opposite directions. Medians of sufficient width can accommodate left-turn deceleration and storage lanes as shown in Figure 8.4. Minimum width is 16 feet, accommodating a 12-foot turn lane and a 4-foot median separator with barrier curbs. Maximum width is 20 feet.

Mountable curbs pose a lesser safety hazard, but are less effective as an access control measure. Wide medians are generally depressed to provide swale drainage (see reference [4] for more details). Barrier medians can also be used for landscaping, pedestrian refuge, placement of traffic control devices and snow storage. An 18-foot median is desirable to allow for left-turn storage and deceleration lanes, accommodating a 6-foot median separator and a 12-foot turn lane. Wide medians can be used to provide for U-turns. See {8.3.1.1} for more details.

This technique is appropriate where there are heavy left turns into a few major driveways. Suggested criteria are an ADT over 10,000 vpd and travel speeds of 30-45 mph and peak hour left turns of over 150 vehicle per mile or if warranted by a high accident rate.

The reduction in turning conflicts should cut accidents in half [30]. However, extra travel is required to reach minor points through the use of U-turns.

8.2.5 Barrier Median With No Left-Turn Access. This median treatment provides access control by prohibiting all direct left turn movements. Demand for the left-turns can be accommodated by indirect left-turns, either a cloverleaf loop or a jughandle. Figures 8.5 and 8.6 are illustrations of these two design types. This design option has the advantage of requiring only a narrow median, since left turn lanes are not required. This option also reduces the number of conflict points and eliminates the need for frequent median openings.

However, these designs increase the number of right-turn conflicts and create a larger number of crossing conflicts at the indirect left-turn locations. They also require considerable right-of-way and have been found to have operational disadvantages which limit their adoption as effective access control techniques. These disadvantages include the extra travel distance required for left-turning traffic, the weaving maneuver generated, and the very short weaving length typically available [4].

As for the median curbs, these fall in two categories: barrier and mountable. Barrier curbs inhibit or discourage vehicles from entering the median, while mountable curbs allow vehicles to cross them easily. Barrier curbs are preferred as an access control strategy since mountable curbs do not provide an effective deterrent to restrict undesirable turning or crossing movements. Figure 8.7 shows several types of median curbs.

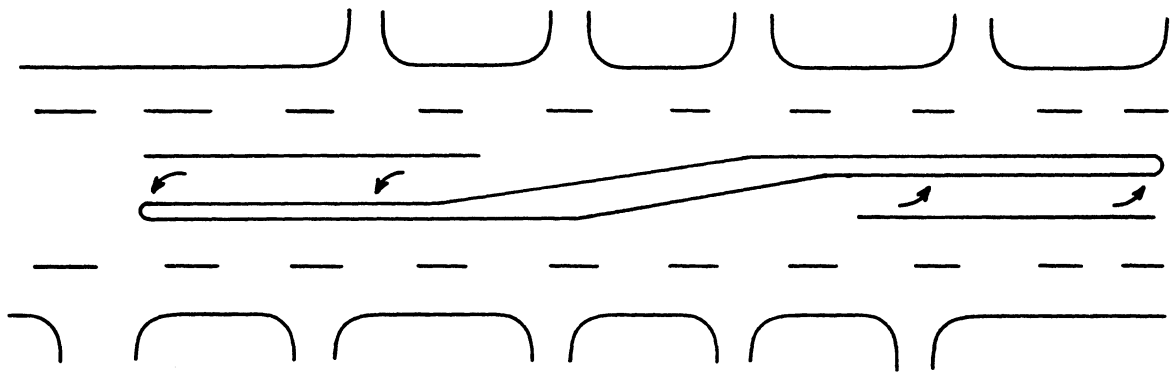


FIGURE 8.4 [30]
BARRIER MEDIAN WITH DIRECT LEFT-TURN LANES

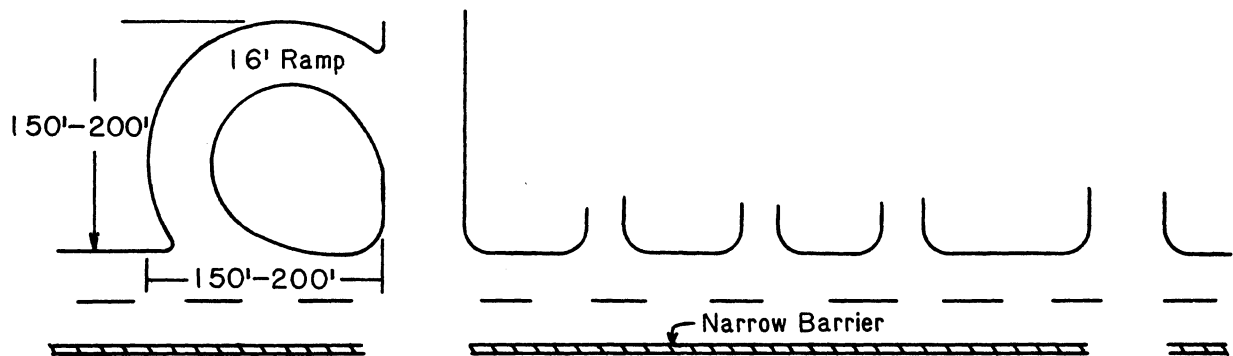


FIGURE 8.5 [30]
CLOVERLEAF LOOP INDIRECT LEFT TURN

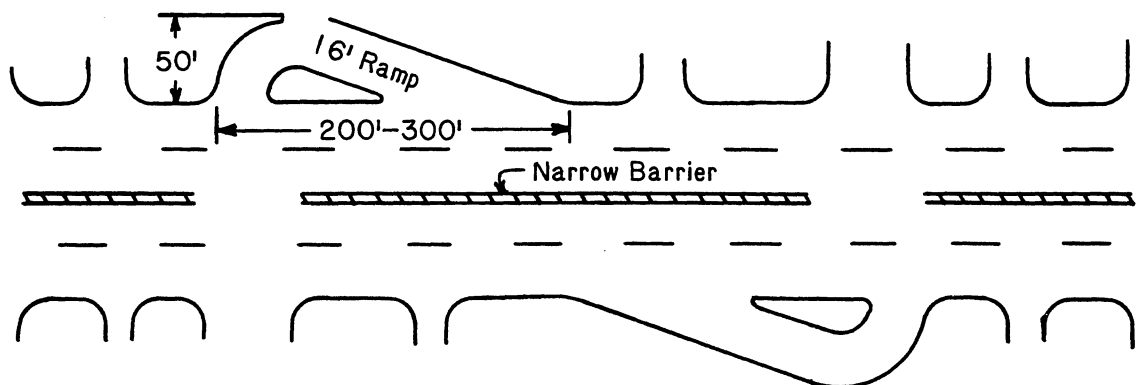
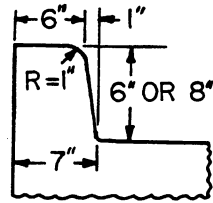
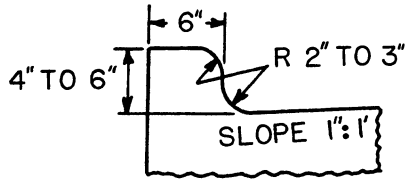


FIGURE 8.6 [30]
JUG-HANDLE INDIRECT LEFT TURN

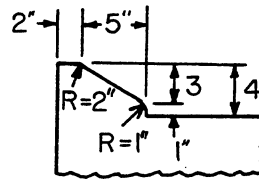


(a)

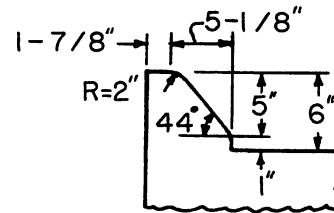
BARRIER CURBS



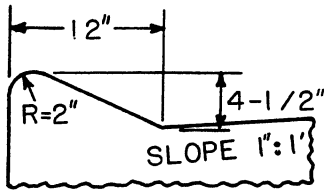
(b)



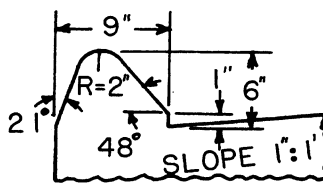
(c)



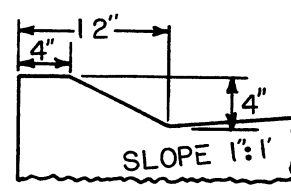
(d)



(e)



(f)



(g)

MOUNTABLE CURBS

FIGURE 8.7 [4]
TYPICAL MEDIAN CURBS

8.3 Median Access Management Techniques

8.3.1 Indirect Left Turns. The cloverleaf loop and the jughandle types have already been mentioned. A third type of indirect left turn is the U-turn.

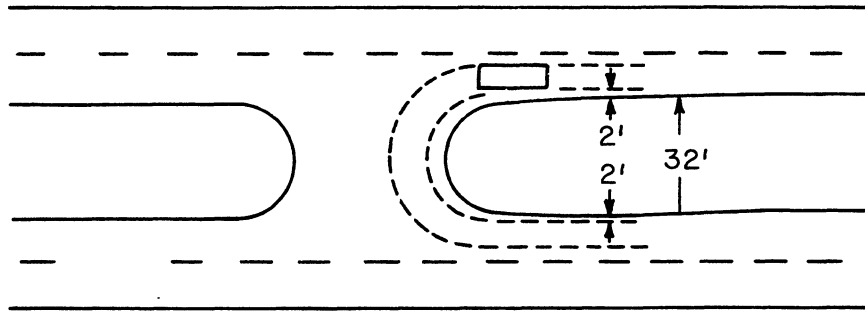
8.3.1.1 U-turns. The U-turn facility should be designed to permit turns from inside lane to inside lane as shown in Figure 8.8 (a). On highways with narrower medians, U-turns can be designed from the turn lane to the opposing outside lane, as shown in Figure 8.8 (b).

AASHTO design vehicle dimensions [2,3,4] are used to calculate the required turning width from different design vehicles. Table 8.1 shows minimum widths of medians for different design vehicles [4]. For the turn-lane to inner-lane design, the turning width is the width of median (Table 8.1) plus the opposing inner lane width, as shown in Figure 8.8 (a). For the turn-lane to opposing outer-lane design, it is the width of median plus the total width of all opposing lanes, as shown in Figure 8.8 (b). The minimum widths are 43 feet for passenger vehicles, 78 feet for single-unit vehicles, and 83 for semi-trailer combinations.

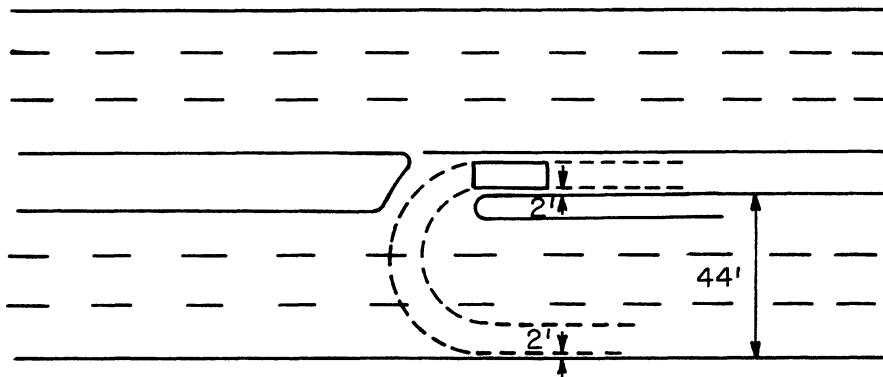
Some locations can only be designed to serve only passenger vehicles. U-turns may also require signalization where there are insufficient gaps in opposing traffic to accommodate the U-turn demand. The U-turn median openings are channelized to allow only a U-turn or left turn with no cross movements. The U-turn receives a flashing red indication. Vehicle detectors actuate a protected green phase only if a continuous presence indication, for several seconds, indicates that acceptable permissive gaps are not available. Only the opposing through lanes are stopped during the protected U-turn phase.

Table A.5 in Appendix A gives recommended dimensions for the distances between median openings. These values range from 290 to 530 feet on urban sections, and from 670 to 910 feet on rural sections. Values greater than 910 feet for rural sections have also been used [1].

Some recommend that the minimum median opening spacing be determined by calculation of deceleration requirements of left-turning vehicles. This procedure minimizes impact on through traffic by allowing left-turn vehicles to decelerate in the turn lane, and adequately separates conflict areas.



(a) U-TURNS, INNER LANE TO INNER LANE,
PASSENGER DESIGN VEHICLE [30]

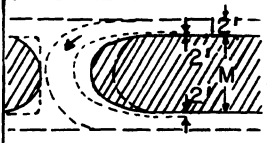
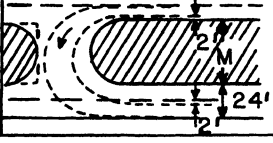


(b) U-TURNS, INNER LANE TO OUTER LANE,
PASSENGER DESIGN VEHICLE [30]

FIGURE 8.8

U-TURNS

TABLE 8.1 [4]
MINIMUM DESIGNS FOR U-TURNS

TYPE OF MANEUVER		M-MIN. WIDTH OF MEDIAN- FEET FOR DESIGN VEHICLE				
		P	WB-40	SU	BUS	WB-50
		LENGTH OF DESIGN VEHICLE				
		19'	50'	30'	40'	55'
INNER LANE TO INNER LANE		32	60	64	68	70
LANE TO OUTER LANE		20	48	52	56	58

Median openings are not necessarily hazardous under conditions of low volume {4.2.2}, wide median (18 foot) and light roadside development {4.3.1}. As volume and development increase, the frequency of median openings has a significant effect on increasing the accident potential. It is generally accepted that the frequency of median openings should be minimized. In many cases, where numerous median openings may present a hazard, they are closed, and a single or a pair of U-turn locations are provided instead. Figure 8.9 shows an application of this technique, for a section of State Road 809 in Palm Beach County, South Florida, in which numerous median openings are replaced by a single U-turn pair.

Median openings should be designed to fit closely the paths of the design vehicles. Bullet-nose end treatments (Figure 8.10 (a)) most closely fit the paths of vehicles and are preferred over semi-circular end treatments (Figure 8.10 (b)) which provide less control by requiring a longer median opening [30]. AASHTO recommends the bullet-nose end treatment and a minimum median opening length of 40 feet as shown in Table 8.2. Median openings at cross streets should be individually designed, dependent upon the design turning radius and cross street configuration. Table A.6 gives recommended dimensions as functions of median width and vehicle type.

An exception to the 40-foot standard is the channelized median opening, because it follows design vehicle paths, exerting a positive control on vehicle paths of travel. Channelization can be used as an access control measure by prohibiting specific undesirable movements.

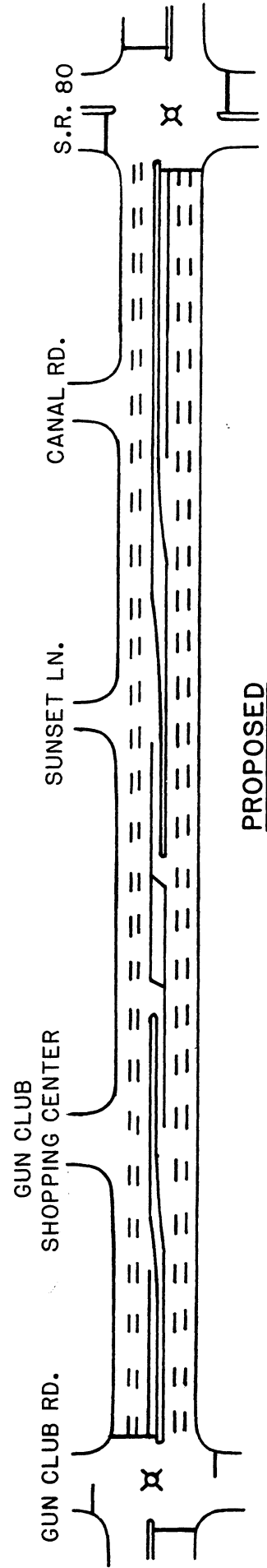
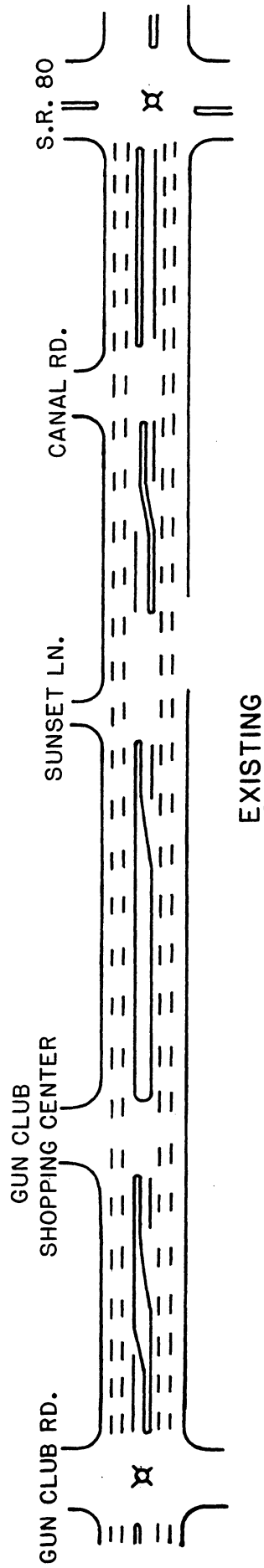
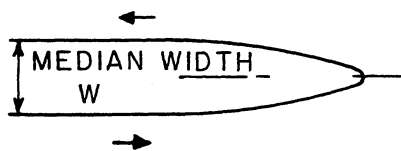
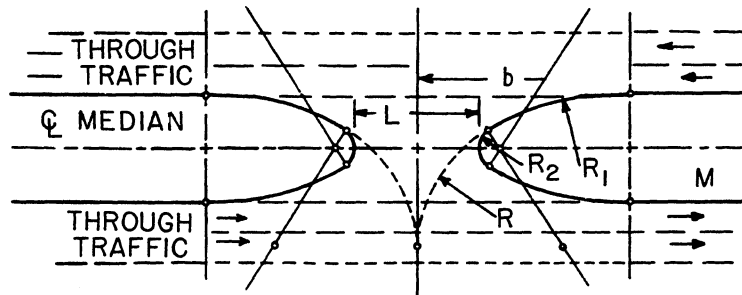


FIGURE 8.9 [30]
MILITARY TRAIL
TYPICAL ACCESS SCHEME

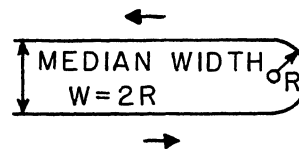
TABLE 8.2
MINIMUM DESIGNS OF MEDIAN OPENING
(TYPICAL BULLET NOSE ENDS)

M WIDTH OF MEDIAN, FEET	DIMENSIONS IN FEET, WHEN					
	R = 90'		R = 150'		R = 230'	
	L	b	L	b	L	b
20	58	65	66	78	71	90
30	48	68	57	85	63	101
40	40	71	50	90	57	109
50	—	—	44	95	51	115
60	—	—	—	—	46	122
70	—	—	—	—	41	128

ASSUMED $R = 50'$
 $R_2 = M/5$



(a) BULLET NOSE



(b) SEMI-CIRCULAR

FIGURE 8.10 [4]
END TREATMENT DESIGN TYPES

8.3.2 Channelization. Channelized median openings can direct vehicles along required paths and can physically restrict specific undesirable movements. This can be an effective access control measure. Median openings on a major road can accommodate one or more of the following movements each: left turns from the major route, left turns to the major route or U-turns.

If the medians are narrow, and left turn hazards are significant, it may be desirable to close the median, or channelize the openings to prevent left turn entry and exit. This technique is applicable to arterial streets with 30 driveways per mile, travel speeds of 30-45 mph and an ADT of at least 5000 vpd. There should be no more than 100 prohibited left turns per day at any location after applying this technique.

On streets with very wide medians (40 feet or more), strategically placed U-turn lanes may be provided to reverse direction if the street pattern in the environs of the artery create circuitous routings.

Figure 8.11 shows how median closures may be accomplished. The first method extends the median to physically prevent left turns from a driveway onto the arterial. This method can reduce accident rates by 20 percent [18], and is common on divided roads with left-turn deceleration lanes at major driveways. The median should be at least 14 feet wide.

The second method channelizes the median to prevent left turns from the arterial into the driveway, and can reduce accident rate by 30 percent [19]. The third method closes the median, and thus prevents all left turns. This method is common for narrow medians and can reduce the accident rate by 50 percent [18].

The effect of restricting movements at one location is to divert them to an alternate route. Resultant weaving, merging, U-turns or other changes in traffic patterns should be considered in evaluating the merit of each design.

Factors affecting the design of median openings include [4]:

1. Turning volumes and type of turning vehicles. For example, where traffic patterns show that nearly all traffic travels through, and the volume is well below capacity, a median opening of the simplest and least costly design may be sufficient.
2. Distance of proposed opening from adjacent intersections or other openings. This spacing must be adequate to allow for introducing left-turn lanes, the length

and width of which is a function of the estimated maximum number of vehicles to be in the lane during peak hours.

3. Traffic control, especially signalization, that will be necessary at the median cut. If a traffic signal at a median cut is within 1500 feet of another traffic signal, the two should be coordinated.

8.3.3 Median Acceleration Lanes. Median acceleration lanes at "T" intersections have not been widely used. They have been found to provide operational benefits, with no significant difference in safety over a conventional "T" intersection [28]. Figure 8.12 shows examples of "T" intersections [4].

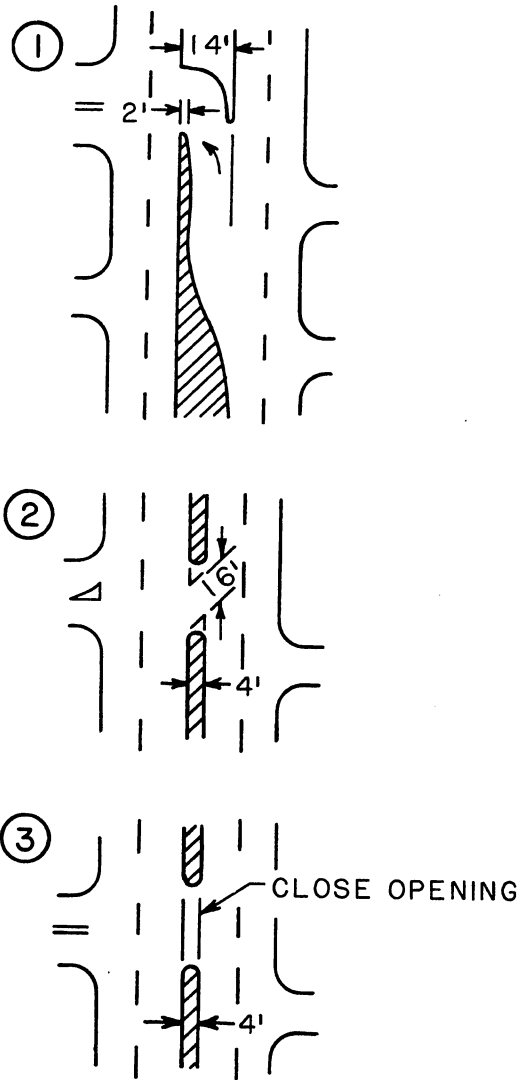
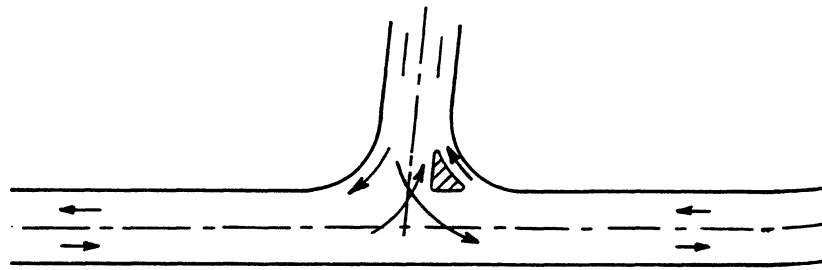
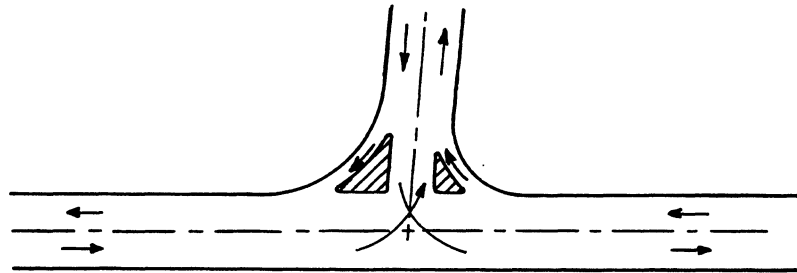


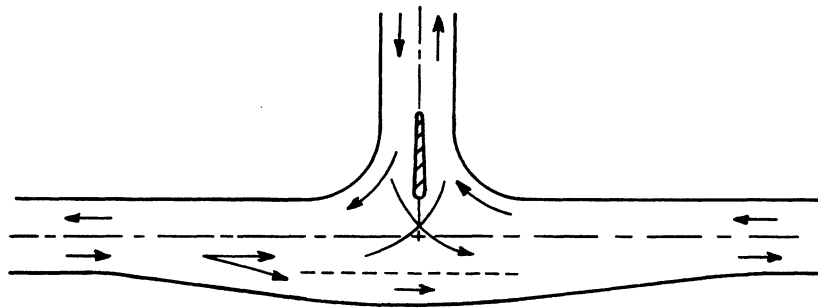
FIGURE 8.11
MEDIAN CLOSINGS [18]



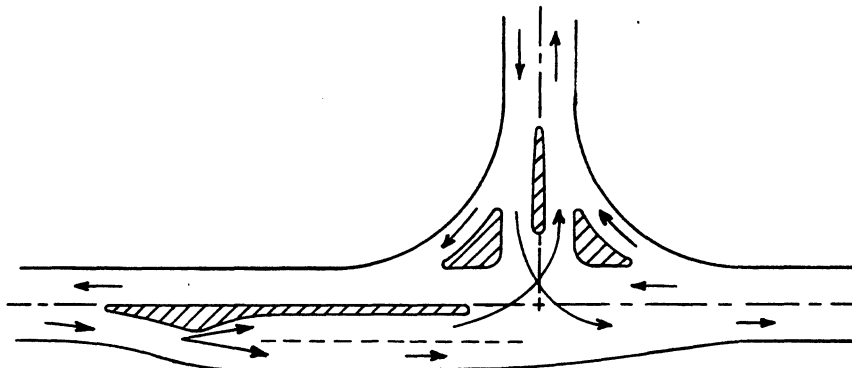
WITH SINGLE TURNING ROADWAY



WITH A PAIR OF TURNING ROADWAYS



WITH DIVISIONAL ISLAND AND RIGHT PASSING LANE



WITH DIVISIONAL ISLAND AND TURNING ROADWAYS

FIGURE 8.12 [4]

TYPICAL CHANNELIZED "T" INTERSECTIONS

8.3.4 Separated Entrance and Exit to a Major Generator. Major developments can generate as much traffic as streets, and their driveways should be designed accordingly. Directional entrances and exits effectively minimize impact on the roadway by separating left turns into the development and left turns out of the development.

8.3.5 Provisions for Left Turns on Undivided Roadways. The roadway should be widened or parking restricted at such locations to create a left-turn lane. Figure 9.8 {9.3.1} illustrates how this could be achieved. Approach taper length and departure taper length (through lanes) should be calculated with the formulas shown in Table A.7 of Appendix A.

8.3.6 Right turn lanes. The advantage of right turn lanes is that they reduce the speed differences in the main travel lanes by removing the turning vehicles from the through traffic and they increase the capacity at signalized intersections.

Figure 8.13 shows some applications of right turn lanes. They can be used to provide access for a single point or as a continuous lane to provide access for several adjoining driveways. In the latter case, the following apply:

- a. Used along arterial roadways with more than 60 driveways per mile. An ADT exceeding 15000 vehicles per day and travel speeds exceeding 30 mph.
- b. The right turns per mile should exceed 20% of the ADT on this segment.
- c. The continuous lane should not exceed one quarter of a mile.
- d. The transition taper should be between 10:1 and 15:1.

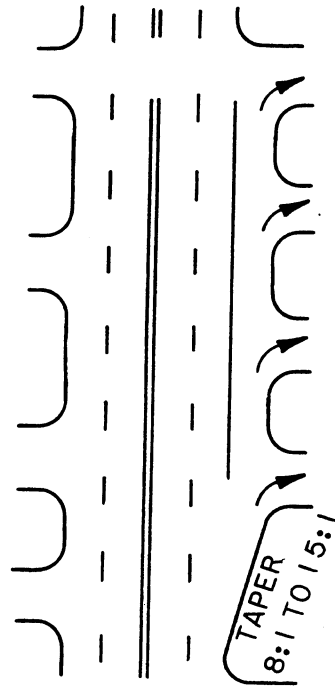


FIGURE 8.13 [18]

RIGHT TURN LANE

8.4 Selection of Median Type

Providing median is a good practice for all major routes. Although it may be infeasible where right-of-way is unavailable, the role of the median in access management should always be considered. Selection of the appropriate median type depends on urban or rural nature of the road's surroundings, cost of median, capacity benefits, safety benefits and local access policy and needs.

Provision of local access is a lesser function of major routes, the primary function of which is to provide traffic movements. The design of access should be considered a means of optimizing the operational characteristics of the roadway.

A Barrier Median, which permits median access control, is preferable on most major routes on which access control is desirable. Curbed medians have lower accident rates than painted medians [14]. Painted medians are most appropriate on roadways with low volume {4.2.2} and a low level of development {4.3.1}. Safety benefits of curbed medians increase with higher ADTs and a higher level of development [1,13].

Recommended median on major routes {4.2.1} with moderate {4.2.3} to high volume {4.2.4} and high roadside development {4.3.3} is usually a barrier median with left-turn storage.

8.5 Traffic Signals

Traffic signal control is primarily needed for high volume driveways {4.4.5} to facilitate outbound left turn and through traffic movements. If the outbound left turn movement is low {4.5.4.2}, the two-way flow on the major route must be stopped for a short period only. This requires separate sensing of the driveway's right and left turn traffic lanes, for efficient signal operations under such circumstances. If this is not done, excessive green time will be allocated to the driveway at the expense of through traffic flow on the major route. The separate sensing could be achieved if the right and left turn lanes are separated and of sufficient width. Reference 30 has details.

Another way to avoid excessive green time being allocated to the driveway involves use of a delay amplifier with one set of loops. This gives a right-turn vehicle an opportunity to clear the intersection without tripping the signal. But, if a right-turn vehicle decides not to enter the intersection during the delay time, the signal will be tripped to allow the vehicle to enter safely, just as if the vehicle were turning left.

The signalization of access along roads must meet the following criteria:

1. The warrants set forth in the Manual of Uniform Traffic Control Devices [20,21] should be met for the specific location.
2. The flow along the arterial must be maintained.

The identification of locations that can be considered for future signalization, when traffic warrants are met, will influence decisions as to the location, type of activity, and circulation design of development along the route. Signalization decisions for intersections of public streets and driveway intersections should be made a part of the initial plan. The locations to be signalized must fit into the signal progression patterns along the road. The design of signals should be sophisticated enough to respond to the varying traffic demands, the objective being to keep the vehicles moving through the intersection [4].

Signalized intersections spacing is an important factor in maintaining the efficiency of traffic flow on streets. Proper spacing is essential if efficient movement is to be achieved at appropriate speeds for major streets. Specific spacing criteria are a function of street patterns, travel speeds and signal cycle length. Major streets should allow for speeds of 40-45 mph on rural routes and 35-40 mph on

urban streets at the off-peak hours and provide for maximum traffic flow rates in peak periods that occur at 30 mph.

Figure 8.14 shows the relationship between speed of progression, cycle length, and signal spacing [22]. A spacing of about one-third mile is needed to take advantage of a range in cycle length and major route speeds. Even then, cycle lengths of 90 seconds and greater will result in speeds less than 30 mph. Quarter-mile spacings will provide for desirable speeds when cycle length is less than 60 seconds. Thus, longer spacings increase the flexibility with which a signal system can be timed to accommodate different traffic demand at various times of the day.

Suggested driveway location and signal coordination guidelines are shown in Figure 8.15. The figure shows how driveway spacing varies with cycle length and speed. A 30 mph speed requires a 1320-foot spacing between the signalized driveway and each cross road with a 60 second cycle. Increasing either the cycle length or driving speed increases the required spacing accordingly.

It is important to note here that the land holding patterns need to be considered in planning signal locations, since they can constrain the choice of signalized intersection spacing. Also, when unsignalized access is permitted, alternative circulation should be provided to a signalized intersection. This will insure that safety requirements at the unsignalized access will not increase to a point where a signal will be required.

Protected signal phases for left turns may be desirable under the following conditions:

1. The peak hour left turn movements exceed 200.
2. Cars must turn left across three or more lanes.
3. Arterial speeds exceed 40 miles per hour.

The Indiana Manual on Uniform Traffic Control Devices for Streets and Highways, Section 4C-10.13, offers these criteria for installing protected left turn indications:

1. Demand for left turns exceeds left turn capacity (1200(G/C) - opposing volume) and delay for left turn vehicles (not less than two vehicles per cycle) is excessive (more than two complete signal cycles) for four hours of an average day.
2. Geometrics, total volume demand, previous accidents of a type susceptible to correction by this installation, speed, etc.

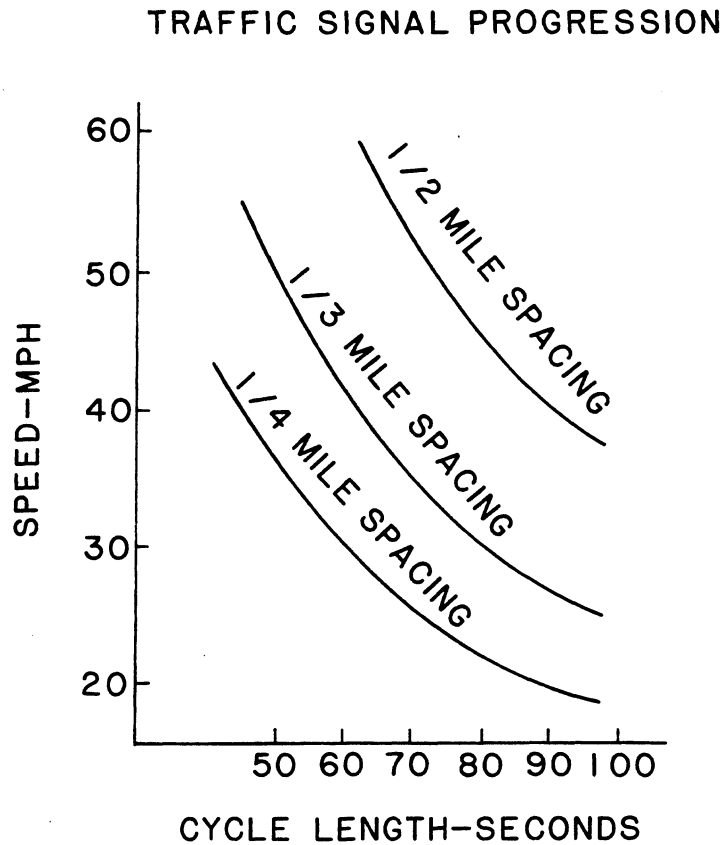


FIGURE 8.14 [30]
SPEED OF TRAFFIC PROGRESSION AS A
FUNCTION OF CYCLE LENGTH
AND SIGNAL SPACING

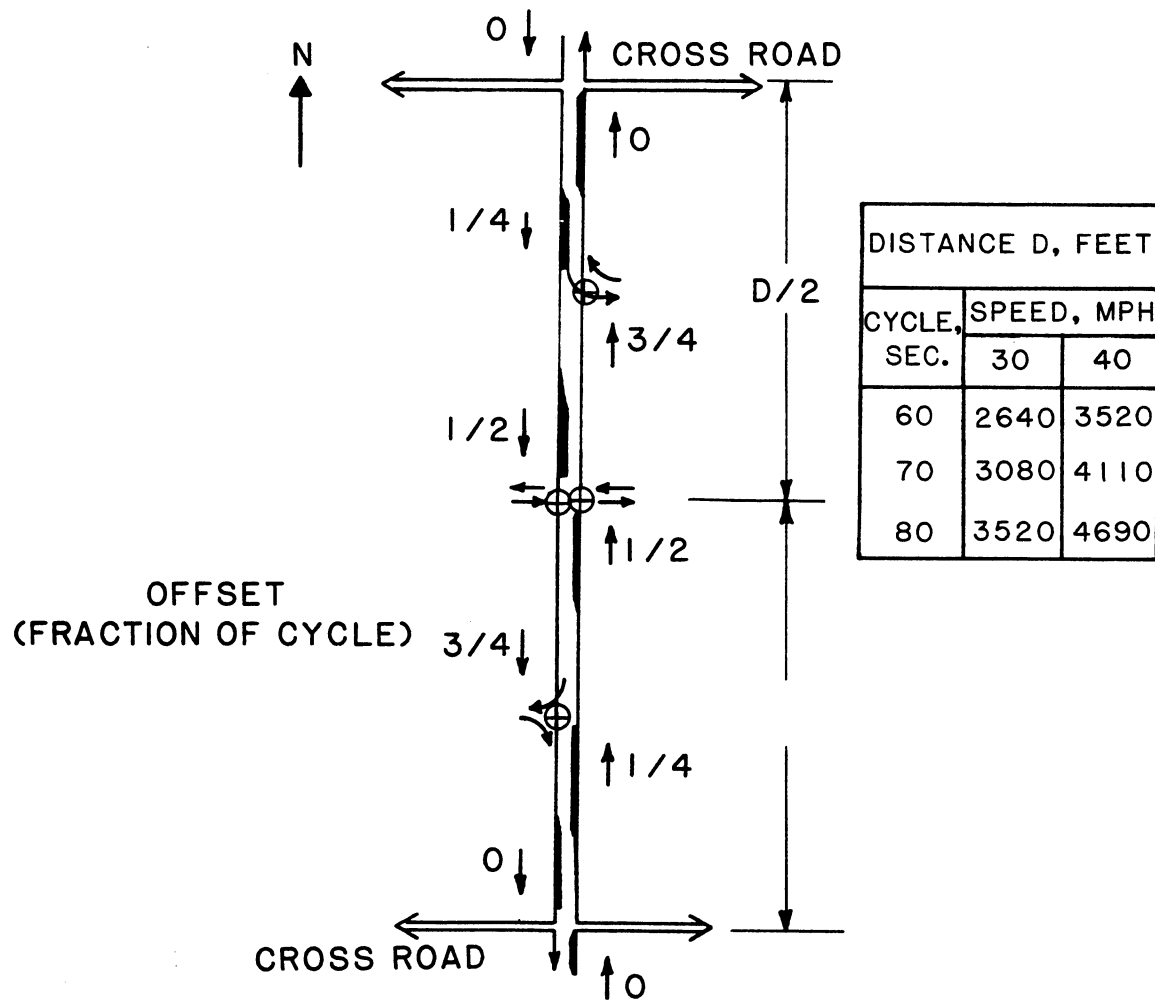


FIGURE 8.15 [18]
DRIVEWAY SIGNALIZATION CONCEPT

Under other circumstances, left turns can be accommodated by gaps in traffic or on the yellow phase. Signalized intersections must have a minimum left-turn storage length of 200 feet.

8.6 Capacity

Each access management plan must provide sufficient capacity for the traffic it is likely to serve. This requires comparing the future volumes the developments would expect to attract, with the capacities that can be provided with the existing and/or improved system.

It is estimated that under average conditions, the capacity of a four-lane arterial street with a 45 mph speed limit will be reduced by over one percent for every two percent of the traffic that turns between the right lane and driveways at unsignalized driveway locations [6]. For example, if a street carries 1,200 vehicles per hour in a direction and 120 turn into driveways and 120 turn out of driveways per mile (20 percent turns), then the capacity in that direction will be reduced by 10 percent. This reduction has the potential to cause the level (quality) of service to deteriorate from the normal design level to a congested condition. This might occur where over 30 percent of traffic is permitted to turn to and from driveways along arterials with strip commercial development. Left-turns can be expected to have an even more severe effect on capacity, in that the deceleration conflict is combined with the crossing conflict.

As the design of the driveway improves (allowing turns to be made at higher speeds), the capacity loss is reduced. Thus, it is desirable to limit driveways to a minimum number, each with a better design.

8.6.1 Techniques to preserve roadway capacity and safety. There are numerous cost-effective ways to preserve or increase roadway capacity and safety [6]. These are listed in Table A.9 of Appendix A. Many of these can be used to improve existing conditions as well as to design new driveways.

9. DRIVEWAY DESIGN AND OPERATION

This chapter presents guidelines for regulating the location, design, construction, and operation of driveways on city streets and urban highways. Also presented are recommended policies and procedures for developing, administering, and enforcing effective driveway regulations within the framework of local government. Much of this chapter is based on the three-volume study, "Guidelines for Driveway Design and Operation", produced in 1980 by the Texas Transportation Institute for the Texas State Department of Highways and Public Transportation [31]. Another excellent resource is "Guidelines for Driveway Design and Location", a 1985 publication of the Institute of Transportation-Engineers [32]. A list of other recommended references is provided at the end of this chapter.

The recommended guidelines, policies, and procedures are applicable to all urban areas, regardless of size, geographic location, or local government structure. They can be used to regulate both new and existing driveways on all city streets and urban highways. The information, however, is most appropriate for regulating driveways on urban roadways with curbs and gutters.

The recommended regulations, policies, and procedures presented here are somewhat general in nature, allowing flexibility to accommodate the variety of situations encountered in urban driveway control. Every effort has been made, however, to minimize the misuse of this flexibility. Desired values and practices are specifically stated where appropriate. Whenever variance from these desired values or practices is permitted, the warranting conditions and limitations of these variances are specifically noted.

Adoption of the regulations, policies, and procedures recommended in this chapter will not guarantee that urban driveways are designed, constructed, operated, and maintained in a safe and efficient manner. This assurance depends on the proper application of these regulations, policies, and procedures by concerned and trained individuals using good judgment.

It should be emphasized that this document does not constitute an official standard, specification, or regulation. Existing state and city regulations, policies, and procedures are not replaced or amended by this document.

9.1 Driveway Location

To enhance traffic safety and operation on urban streets and highways, driveways should be located a sufficient distance from other driveways and intersecting streets. They should also be positioned so that driveway users have adequate sight distance to oncoming traffic.

9.1.1 Number of Driveways. As more and more driveways are constructed along a street, the accident rate tends to increase and roadway capacity decreases. Therefore, every development (or land parcel) should have only the minimum number of driveways needed to efficiently handle the traffic volumes generated by the development.

A development (or land parcel) should have only one two-way driveway or one-way driveway pair. A corner property may have a two-way driveway or one-way driveway pair on both streets, if it has enough frontage on both streets to provide adequate driveway spacings and corner clearance.

If adjacent land parcels have frontage lengths so narrow that minimum driveway spacing requirements would be violated by allowing each parcel a separate driveway, then a common driveway serving both parcels should be encouraged.

A development may have more than one two-way driveway or one-way driveway pair on a street only under one of the following conditions:

1. The total volume of traffic generated by the development will exceed 5,000 vehicles per day.
2. The traffic volume generated by the development will exceed the capacity of a stop sign controlled intersection during the peak hour.
3. A competent traffic engineering analysis indicates that traffic conditions at the site warrant more driveways (e.g., to facilitate on-site traffic circulation)) and that providing additional driveways will not adversely affect traffic safety or operation on the street.

If multiple driveways are justified under one of the above conditions, minimum driveway spacings and corner clearance must be provided. These minimum spacings and clearances are presented in a later section of this chapter. Also, at some major traffic generators (e.g., a regional shopping mall), it may be desirable to signalize one well-designed driveway to obtain the needed capacity, rather than constructing additional unsignalized driveways.

9.1.2 Spacing Between Driveways. Driveways should be spaced far enough apart so that conflicting movements at adjacent driveways do not overlap, which would thus increase the accident potential and/or reduce roadway capacity. Desirable minimum driveway spacings are presented in Tables 9.1, A.2, and A.3.

If individual property frontage lengths along a street are several hundred feet, providing adequate driveway spacing is generally not a problem. In these cases, adjacent driveways should be spaced as far apart as access and on-site circulation needs will permit. If the land along a street is subdivided into small lots, however, providing adequate driveway spacing becomes a critical problem and is very difficult to attain. The critical requirement of driveway spacing must be considered during land subdivision.

Driveway spacing is particularly critical on arterial streets. If the minimum spacings cannot be attained on arterial streets, then joint access driveways should be encouraged.

It should also be noted that special conditions at a driveway (e.g., installation of acceleration/deceleration lanes, driveway signalization, etc.) will increase the spacing requirements. These should be evaluated on an individual basis.

9.1.3 Corner Clearance. The spacing between a driveway and an adjacent street intersection (corner clearance) should be regulated to enhance traffic safety and operations in the intersection area. Corner clearance control is sometimes difficult, however, due to the existence of corner properties with insufficient frontage lengths to enable good driveway location. Corner clearance requirements should therefore be considered when subdividing land.

Corner clearance requirements for commercial and industrial driveways on arterial streets are presented in Table 9.2.

Corner clearance requirements for commercial and industrial properties on collector and local streets are presented in Table 9.3. Corner clearance at residential driveways on collector and local streets is generally not critical. (See Table A.1 in Appendix A.) The desirable minimum corner clearances shown in Table 9.2 and 9.3 are those needed to ensure that conflicting driveway and intersection movements do not overlap.

If the desirable minimum corner clearances cannot be provided, then one of the following measures should be

Table 9.1 Minimum Spacing Between Driveways [31]

Street Type	Speed Range, MPH	Minimum Spacing Between Driveways, Feet ^{a,b}
Arterial	35-40	200
Collector	30-35	150
Local	25-30	50 ^c

(a) These spacings are measured from driveway throat to driveway throat, as shown by "S" in Figure 9.1.

(b) These minimum spacings can be halved if the adjacent driveways are one-way driveways.

(c) Residential driveway spacings on local streets are not critical and are exempted.

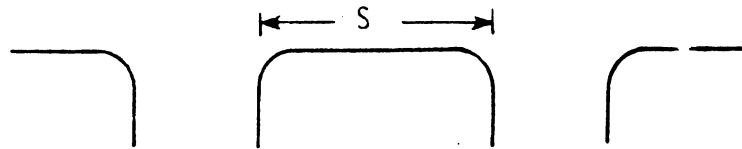


Figure 9.1 Measuring Driveway Spacing [31]

Table 9.2 Corner Clearance: Commercial and Industrial
Driveways on Collector and Local Streets [31]

Street Type	Minimum Corner Clearance, Feet ^a	
	Desirable Minimum	Absolute Minimum
Collector	100	50
Local	100	50

(a) Measured from intersection curb to nearest driveway curb.

Table 9.3 Corner Clearance: Commercial and Industrial
Driveways on Arterial Streets [31]

Intersection Type	Minimum Corner Clearance, Feet ^a	
	Desirable Minimum	Absolute Minimum
Arterial-Arterial	300	250
Arterial-Collector	200	125
Arterial-Local	100	50

(a) Measured from intersection curb to nearest driveway curb.

taken:

1. Left turns should be prohibited at the driveway.
2. Access to the corner property should be limited to the collector or local street approach.
3. Common access with a neighboring property should be sought.

9.1.4 Property Line Clearance. No part of a driveway, including the curb return, should extend over a property line or the perpendicular extension of a property line through the street right-of-way. This requirement does not pertain to joint driveways that are constructed on a property line, with the property owner's consent, to serve both properties.

The minimum property line clearances shown in Table 9.4 should be maintained for commercial and industrial driveways. These property line clearance requirements are intended to promote adequate driveway spacings. It is recognized that in urban areas these property line clearance requirements may be too restrictive for some sites. When variation from these minimum clearances is proposed, however, an engineering evaluation must be conducted to determine if the reduced clearance will have an adverse impact on traffic safety or operations on the street. In addition, it will be necessary to coordinate driveway placement with the neighboring development.

9.1.5 Minimum Sight Distance. A driveway should be located to the maximum extent possible, at the point of maximum sight distance along a property frontage. Placement of a driveway in a horizontal curve along a street or just below the high point of a crest vertical curve should be avoided.

Safe stopping distance must be provided at every driveway for all traffic movements that are permitted at the driveway. Minimum safe stopping sight distances for a range of street operating speeds (posted speed limits) are shown in Table 9.5. The distances in the table are absolute minima; sight distances much greater than these should normally be used.

Desirable minimum sight distance requirements for commercial and industrial driveways are presented in Tables 9.6 and 9.7. (See also Figure 9.2.) The values presented are minimum sight distances which would permit the following:

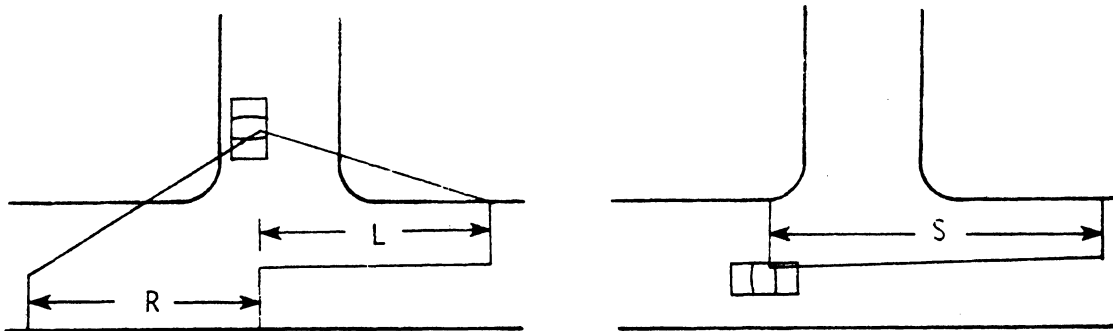
Table 9.4 Property Line Clearances for Commercial and Industrial Driveways [31]

Street Type	Minimum Property Line Clearance, Feet ^a
Arterial	100
Collector	75
Local	50

^aThese clearances are measured from the driveway throat to the property line or perpendicular extension of the property line through the street right-of-way.

Table 9.5 Safe Stopping Sight Distances [31]

Operating Speed, MPH	Absolute Minimum Sight Distance Feet
20	100
25	150
30	200
35	250
40	275
45	325
50	350



R - Sight distance for exiting traffic looking Right (measured from a driveway vehicle stopped 10 feet back of the street to a vehicle approaching in the lane nearest the median).

L - Sight distance for exiting traffic looking Left (measured from a driveway vehicle stopped 10 feet back of the street to a vehicle approaching in the outside lane, i.e., the lane nearest the curb).

S - Sight distance for entering traffic looking Straight ahead (measured from the point where a left-turning vehicle stops to a vehicle in the outside approach lane).

Figure 9.2 Key to Dimensions in Tables 9.6 and 9.7

Table 9.6 Safe Sight Distance for Passenger Cars (feet)

Operating Speed, mph	Two-Lane Streets			Four-Lane Streets		
	R	L	S	R	L	S
20	130	150	150	130	130	160
30	260	350	230	260	220	250
40	440	530	370	440	380	390
50	700	740	520	700	620	550

Table 9.7 Safe Sight Distance for Trucks (feet)

Operating Speed, mph	Two-Lane Streets			Four-Lane Streets		
	R	L	S	R	L	S
20	200	300	260	200	200	280
30	400	500	400	400	400	440
40	850	850	570	850	850	620
50	1600	1600	810	1600	1600	880

1. Upon turning left or right, an exiting vehicle could accelerate to the operating speed of the street without causing approaching vehicles to reduce speed by more than 10 mph.
2. Upon turning left, an exiting vehicle could clear the near half of the street without conflicting with vehicles approaching from the left.
3. A vehicle turning left into the driveway would safely clear oncoming through traffic without affecting the speed of through traffic.

The safe sight distances in Tables 9.6 and 9.7 were developed for urban conditions and assume level grades. The values should be increased or decreased as appropriate to allow for the effects of grade on vehicle operation.

The desirable minimum sight distances are based on the premise that driveway maneuvers should not severely degrade traffic flow on an urban street. Actual sight distances provided at driveways should be much greater than these minimum values, if practical.

Any movement for which sight distance is inadequate (e.g., left turn exit or left turn entry) should be prohibited by signs, pavement markings, and restrictive design features, as needed. If safe sight distance is not available at any point along the frontage of a property, common access with a neighboring property or access to another street (in the case of corner properties) should be obtained.

Direct access to a property should be denied when minimum safe sight distance cannot be attained for the necessary ingress and egress movements. When direct access is denied, indirect access may be allowed, at the property owner's expense, in one of the following ways:

1. Paying compensation to adjacent property owners to acquire access to the subject parcel through easements.
2. Constructing a frontage road serving the subject property and connecting with a highway where safe access can be provided.

It is strongly suggested that access sight distance elements be made a part of local zoning standards. Zoning controls can be used to restrict certain types of developments on parcels where it would be impossible to provide proper sight distances for the types of vehicles generated

by such developments.

Every city and county should develop and adopt an effective policy for regulating the placement of advertising signs, trees or shrubbery, etc., within a street or highway right-of-way or so near the right-of-way that sight distance is critically obstructed.

9.2 Driveway Geometry

9.2.1 Width and Curb Return Radius. Driveway width and curb return radius interact to affect vehicle speed and path. The selection of an appropriate width must be coordinated with curb return radii selection to achieve desirable driveway operation and safety.

Table 9.8 presents width and curb return radius requirements for two-way driveways and one-way driveways. The desirable values shown in the tables should be used whenever possible. If variation from these values is required because of site conditions, the width and radii selected should be as close as possible to the desired values. Using both a small width and curb return radius should be avoided. Generally, if the width must be greatly reduced, then curb return radius should be increased, and vice versa.

Some additional considerations regarding driveway width and curb return radii are presented below and in Table A.2.

1. The width of the street right-of-way should not be a limiting factor in selecting the appropriate curb return radii. Curb returns should extend onto private property if necessary.
2. At high-volume commercial and industrial driveways, off-set taper approach treatments, as shown in Figure 9.3, may improve entering vehicle paths. However, they do not significantly affect entry speeds. A typical design might include a 100-foot spiral taper resulting in a 9 to 10-foot offset.
3. If more than 100 vph turn left from a driveway during the peak hour, two exit lanes should be provided. Driveway width should be increased appropriately.
4. If a commercial development is serviced by moderate truck traffic (i.e., delivery trucks), it may be desirable to provide one well-designed "industrial" driveway for these vehicles and prohibit the use of the "commercial" driveways by these trucks.

Table 9.8 Width and Curb Return Radius Requirements

Two-Way Driveways

Driveway Type	Width, Feet			Curb Return Radius, Feet		
	Desirable	Maximum	Minimum	Desirable	Maximum	Minimum
Residential	20	25	12	5	15	2½
Commercial	30	35	25	20	30	10
Industrial	35	40	30	30	--	15

One-Way Driveways

Driveway Type	Width, Feet				Curb Return Radius, Feet		
	Desirable		Maximum	Minimum	Desirable	Maximum	Minimum
	Entry Drive	Exit Drive					
Residential	15	15	20	12	5	15	2½
Commercial	18	16	20	15	20	30	10
Industrial	20	20	25	15	30	--	15



Figure 9.3 Offset Taper Approach Treatments

5. At high-volume industrial driveways, the use of compound curves in the curb returns is recommended.

9.2.2 Throat Length. For commercial and industrial driveways, throat length refers to the distance from the street to the point where driveway traffic comes into conflict with traffic in the parking or on-site circulation area. For residential driveways, throat length is the distance from the street to the end of the driveway (e.g., the garage, carport, etc.).

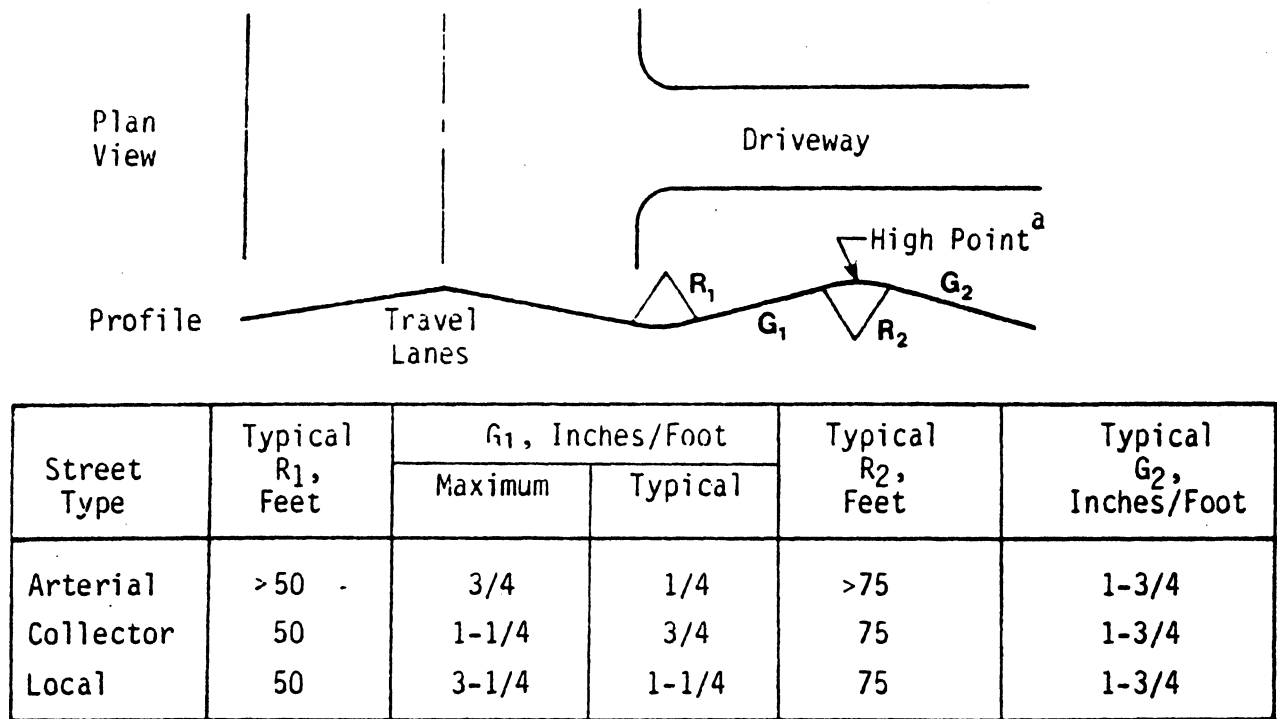
The throat length of residential driveways is not particularly critical, but it should be long enough to accommodate a passenger car completely clear of the street and sidewalk if one exists.

The throat length of commercial and industrial driveways is a critical driveway design feature. Sufficient length must be provided to store exiting vehicles clear of the parking and on-site circulation area. This length will depend upon anticipated exit queue lengths during the peak hour. Exit queue length is a function of driveway and street traffic volumes, as well as vehicle type. At major driveways, a queueing analysis (using expected arrival and departure rates) should be conducted since at some driveways (e.g., regional shopping malls), up to 200 feet of storage may need to be provided.

Even if exiting vehicle storage requirements are minimal, throat length should be as great as practical in order to: 1) move the parking/circulation area conflict point away from the driveway entrance and 2) encourage proper use of the driveway, in the case of two-way driveways, by exiting traffic. A minimum throat length of 25 feet is suggested, although greater lengths are desirable. Tables A.2 and A.8 provide guidelines for certain specific situations.

9.2.3 Profile. Driveway profile is an important element of driveway design. It influences the speed and path of driveway users and therefore affects driveway operation and safety. It also affects street and driveway drainage.

It is difficult to recommend a single set of standards for driveway profile, since conditions (e.g., terrain, street cross-section, etc.) vary greatly from one site to the next. In fact, there are currently no standards available that have received widespread acceptance. Some general profile guidelines for typical driveways on a curbed street are presented in Figure 9.4. (See also Table A.2.)



^aThe high point should be 1 or 2 inches higher than the top of the street curb at the upstream end of the driveway.

Figure 9.4 General Profile Guidelines:
Typical Driveways on Curbed Streets

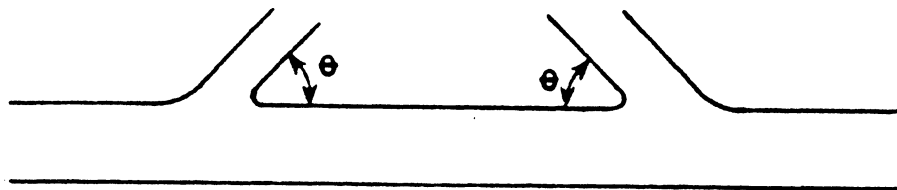


Figure 9.5 Approach Angle θ

The guidelines in Figure 9.4 are applicable to residential and commercial driveways only. Truck dimensions and operating characteristics must be considered when designing industrial driveways. However, there are currently no guidelines available for industrial driveway profiles.

9.2.4 Approach Angle. The angle at which a driveway intersects the street (Figure 9.5) affects the field of vision, speed, and path of motorists using the driveway. Approach angles also interact with other design features (e.g., width, curb return radius, throat length, channelization, etc.) to encourage or discourage particular types of driveway operation and maneuvers.

All two-way driveways and one-way driveways with unrestricted turning movements should intersect the street at a 90 degree angle. If site conditions (e.g., terrain, lot size and shape, etc.) will not permit a 90 degree approach angle, the angle may be reduced, but not below these values:

1. 70 degrees for commercial and industrial driveways.
2. 60 degrees for residential driveways.

If an approach angle of less than 90 degrees must be used at one of these driveways, the driveway curb return radius and/or width should be increased to facilitate maneuvers made difficult as a result of the undesirable approach angle.

At one-way driveways where only right turns are permitted (e.g., a one-way driveway pair on a divided street), it may be desirable to flatten the approach angle below 90 degrees to increase entry or exit speeds. Under these conditions, an angle of approximately 60 degrees is recommended, with the following exceptions:

1. At driveways where sidewalk pedestrian traffic is heavy, the approach angle should not be reduced below 70 degrees. Smaller angles encourage high vehicle speeds and a pedestrian safety problem may result.
2. If an acceleration or right turn lane is provided at an exit driveway, the angle may be reduced to 45 degrees.
3. At industrial driveways that serve large trucks, the angle may be reduced to as low as 30 degrees to facilitate driveway operation. Angles less than 30 degrees result in severe visibility limitations and are discouraged.

See also Table A.2.

9.2.5 Acceleration/Deceleration Lanes. To enhance traffic operation and safety on arterial streets, acceleration and/or deceleration (turn) lanes may be provided at high volume driveways. Turn lanes should be designed to the same standards as turning lanes at arterial street intersections (see AASHTO's A Policy on Design of Urban Highways and Arterial Streets [2]).

There are no specific warrants for the use of an acceleration lane at a driveway. However, an acceleration lane may enhance safety and increase driveway capacity whenever arterial street speeds are high (e.g., 40 mph or greater) and/or right turn exit volumes from the driveway are heavy. An acceleration lane also can enhance the safety and operation of a flat angled exit driveway, since angled driveways encourage high speed exit maneuvers and restrict driveway users' view of approaching street traffic.

A deceleration lane should be installed at a driveway on an arterial street if 1) the average daily two-way volume at the driveway is at least 1000 vehicles, and 2) the average peak hour entering right turn volume is at least 40 vehicles. If two or more successive driveways meet this warrant or if adjacent driveways are spaced so close that a deceleration lane at the downstream driveway would encroach into the upstream driveway, a continuous right turn lane should be used. Continuous right turn lanes should also be provided when more than 20 percent of the traffic traveling in one direction on an arterial turns right into driveways along the arterial.

When a deceleration lane is installed at a driveway, no other driveways should intersect the street within the deceleration lane or approach taper to the lane.

9.3 Traffic Control

Driveway traffic control devices (i.e., signs, pavement markings, channelization islands, and traffic signals) should be used in accordance with the Manual on Uniform Traffic Control Devices for Streets and Highways [20]. Some additional guidelines on the use of traffic control devices at driveways are presented in the following sections.

9.3.1 Signing. Driveway signing is most effective when the intent of the signing is supported by the design and layout of the driveways and the parking area. Situations where

signing allows motorists to make a difficult, illogical, or unsafe maneuver should be avoided.

Left turn prohibition signing is particularly susceptible to violation. Every effort should be made to support left turn prohibition signing through appropriate design (e.g., small curb return radius, angled driveway, raised median in the street, driveway channelization, etc.).

9.3.2 Pavement Markings. At one-way exit driveways where illegal entry maneuvers are frequent, white stop bars placed across the full width of the driveway may be used to discourage the illegal maneuvers. The stop bar must be visible to street traffic to be effective.

It should be noted that most driveway pavement markings are difficult to see from the street and, therefore, it may be more appropriate to use signs to present information to entry traffic at driveways.

9.3.3 Channelizing Islands and Driveway Dividers. At high-volume commercial or industrial driveways, it may be desirable to control or confine particular maneuvers by installing channelizing islands and/or a median divider (at two-way driveways). Channelizing islands and median dividers at driveways should be designed to the same standards recommended for islands and dividers installed at street intersections. (See Policy on Design of Urban Highways and Arterial Streets published by AASHTO [2]).

Island and median shapes and sizes can vary considerably, depending on site requirements; however, all islands should have an area of at least 50 square feet, and preferably 75 square feet. Triangular islands should be at least about 8 feet, and preferably more than 12 feet, on a side. Median dividers should be at least 4 feet wide and 12 to 20 feet long, as a minimum.

All driveway channelizing islands should be highly visible both day and night. The curbing of raised islands and median dividers should be painted with beaded paint.

Raised channelization at some driveways can create a significant safety hazard, particularly to motorcyclists. Therefore, if the needed traffic control can be achieved with a lesser degree of channelization (e.g., raised pavement markers or painted islands), then the less obtrusive channelization technique should be used.

Raised channelization can also adversely affect surface drainage of the street and driveway throat. All islands and

median dividers must be designed so that surface drainage is not impeded.

Regulatory signing and/or pavement markings must be used along with channelizing devices to effectively and legally prohibit particular driveway movements.

9.3.4 Signalization. At high-volume commercial and industrial driveways, traffic operations and/or safety may be enhanced by installing a traffic signal. Signalization of a driveway should only be considered if traffic volumes or past accident experience warrant a signal at the driveway. Traffic signal warrants appropriate for driveways are presented in the Indiana MUTCD.

Even if conditions at a driveway warrant a traffic signal, the final decision to install one should be based on a traffic engineering study of the particular driveway site. This study should consider the effects that driveway signal installation will have on traffic operations at nearby signalized street intersections.

To achieve optimum traffic flow conditions along a street or highway, it is desirable to have a spacing of 600 to 700 feet between a signalized "T" driveway and an adjacent signalized street intersection. Four-legged signalized driveway intersections should be spaced 1500 to 2000 feet from an adjacent signalized street intersection to achieve optimum traffic flow along the street.

At all signalized driveways, it is strongly recommended that a separate turn lane be provided on the street for traffic turning left into the driveway. Driveway signals should be semi-actuated, with detectors provided for this entering left turn movement and for all exiting movements from the driveway. Driveway signals within 2500 feet of a signalized street intersection should be interconnected and coordinated with the intersection signal.

At signalized driveways where there is significant pedestrian traffic, pedestrian signals should be included as part of the signal installation. Guidelines for pedestrian indications are presented in the Indiana MUTCD.

9.4 Parking and On-Site Traffic Circulation

Driveway location, design, and operation must be fully coordinated with parking facilities and on-site traffic circulation at all driveways on arterial streets and at high-volume commercial and industrial driveways.

9.4.1 Regulation. On-street parking should be prohibited within at least 20 feet of the curb returns of commercial or industrial driveways, and where it obstructs the view of drivers entering or leaving a driveway or conceals a driveway from street traffic. On-site parking should be designed so that parked cars on a property do not obstruct the sight distance at a driveway or conceal a driveway to street traffic.

An efficient on-site traffic circulation pattern at a commercial or industrial development is important to driveway operation and safety. The circulation pattern must be consistent with the type of driveway operation (one-way or two-way). The circulation pattern should not require on-site traffic to cross or conflict with driveway traffic or to use the street (via a driveway) as part of the pattern.

9.4.2 Service Fixtures. Service fixtures (i.e., gasoline pumps, mail boxes, etc.) should be placed as far from driveways as practical, so that traffic using the service fixtures does not interfere with normal driveway operation. At service fixtures where queueing may occur, it is important to provide an adequate and well-defined storage area for the waiting traffic. This storage area should be located so that the waiting vehicles do not block or impede the movement of driveway traffic.

9.4.3 Drive-Up Windows. Drive-up windows, like other service fixtures, should be placed as far from driveways as practical, so that traffic waiting at the window does not affect driveway operation or safety. Drive-up windows should also be located and operated in a manner that is consistent with the type of driveway operation being encouraged.

Providing an adequate and well-defined storage area for drive-up window traffic is particularly critical, especially at fast-food restaurants and motor banks where queues can become quite long. All waiting traffic must be stored on private property clear of driveways. Otherwise, safety and operation at driveways and/or on the street may be adversely affected.

The drive-up window design in Figure 9.6 is recommended for all single-window drive-up facilities where on-site storage is a problem (e.g., shallow lots, long service times, high volume of window users, etc.).

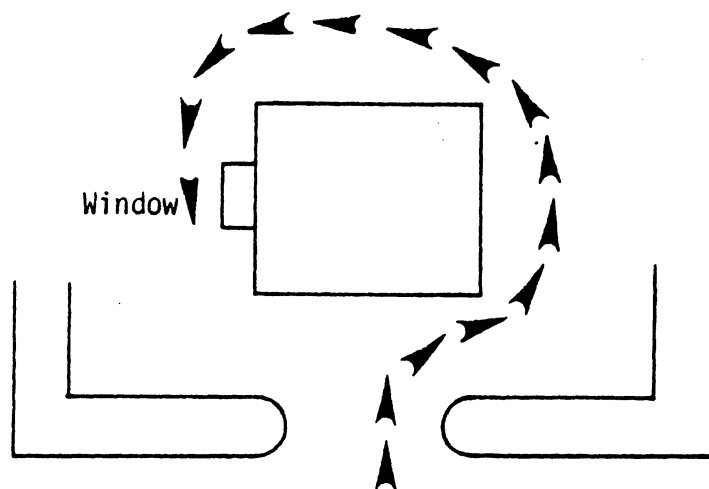


Figure 9.6 Drive-up Window On-site Storage

9.5 Driveway Operation

A two-way driveway can efficiently serve several hundred vehicles per hour (vph) if properly designed. The capacity of a two-way driveway is essentially the same as a stop controlled "T" intersection.

If peak hour volumes exceed 100 vph, a divided driveway or one-way driveway pair should be considered in lieu of a two-way driveway. One-way operation is particularly desirable when there are over 40 left turns per hour at a driveway and property frontage exceeds 200 feet in length.

Driveway design must be completely coordinated with the type of driveway operation. Design standards should be developed that recognize the different operational requirements of one-way versus two-way driveways.

9.5.1 Turn Prohibitions. Prohibition of certain turning movements at a driveway, if needed, should be accomplished by restrictive driveway design features and reinforced by regulatory signing and pavement markings.

Left turn movements into and out of driveways are most commonly prohibited. Left turn prohibition can be advantageous under the following conditions:

1. The spacing between the driveway and an adjacent intersection (corner clearance) is inadequate.
2. There is inadequate sight distance at the driveway to safely perform a left turn maneuver.
3. The spacing between the driveway and an adjacent driveway is inadequate.
4. If a property parcel has a signalized driveway at which left turns can be made, left turns at the unsignalized driveways on the same approach should be prohibited.
5. Other capacity, traffic delay, or safety conditions, as determined by a traffic engineering study, may warrant left turn prohibition at particular driveway sites.

Left turn prohibition at driveways is most effectively achieved by physically restricting the left turn maneuver with median channelization (if a median exists) or driveway channelization. Driveway channelization, however, is not totally effective and should be supplemented with regulatory signing.

9.5.2 Median Crossings. Median openings regulate left turn maneuvers into and out of driveways. To achieve optimum traffic flow conditions on a divided street, the spacing between median openings should be at least 400 feet. The spacing may be reduced to a minimum of 300 feet if a competent traffic engineering study indicates that the lesser spacing will safely and efficiently accommodate left turn movements to existing and future land development.

Generally speaking, median openings should not be provided at individual driveways, but rather at public street intersections. The exception to this policy would be at access points to major traffic generators where the access points (major driveways) conform in all respects to the standards for intersection spacing and design.

Median openings should be of the "bullet-nose" design [ref?] to facilitate turning movements through the opening. Medians should be designed and constructed to prevent crossing except at designated points.

9.6 Policies

In order to enhance the overall effectiveness and efficiency of driveway regulation and ensure due process of law, it is critical that formal access control policies and procedures be established. The following sections will discuss recommended policies and procedures for developing, administering and enforcing driveway regulations within the framework of local government.

9.6.1 Responsibility. The governing bodies of all cities, counties, and states, through their charters or constitutions, have the responsibility to protect public health, safety, and general welfare. Since inadequately designed or operated driveways contribute to traffic accidents and reduce the operational efficiency of a street or highway, it follows that a city, county or state has the responsibility to regulate all driveways or roadways under its jurisdiction.

9.6.2 Authority. Every state has enacted legislation (see Indiana Code 9-4-1-119) that makes it legal to regulate driveways. The power to regulate driveways, and property access in general, is a "police power" and, unlike the power to take property (the power of eminent domain), does not require compensation to the owner for inconveniences or for any consequential effects of the regulation. However, driveway regulation must not deny any citizen due process of

law. In other words, the power that a city, county or state exercises to control driveways must be appropriate for individual situations. Regulations must be practical, fair, and responsive to varying conditions.

9.6.3 Policies. Effective urban driveway regulation begins with the consideration of access in the local subdivision, street and zoning ordinances, and the adoption of an effective driveway ordinance. (In some cities, one or more of these ordinances are combined).

9.6.4 Street and Subdivision Development. In order to have good driveways, driveway access must be considered in the earliest stages of street and subdivision planning and layout (e.g., long before streets are constructed, land is subdivided, houses or business are built, etc.). Local street and subdivision ordinances should encourage safe and efficient driveway design and operation by incorporating the following provisions:

1. Lots with inadequate width, depth or frontage length or with a confining shape for their intended land use should be avoided.
2. Building and fixture setback requirements that encourage good driveway location and design, and efficient on-site traffic circulation, should be established.
3. Streets should be laid out with adequate right-of-way to accommodate present and future needs. Attention should be given to providing adequate intersection spacing. In particular, intersections that are signalized should be spaced to permit efficient corridor traffic flow.
4. Curb and gutter should be required on all city streets, or at least on all non-residential streets.
5. Street design and layout should be consistent with intended land use and street function.

Optimum block lengths (intersection spacings) should be established which consider the needs of land access. A new subdivision should not create any land parcels intended for single-family or duplex residential uses fronting on an arterial street.

9.6.5 Driveway Regulation. Driveway regulations should recognize the needs and interests of all parties concerned if they are to be accepted. They should reflect what is safe, effective, and practical, rather than a political compromise that "everyone can live with". They should be general enough to permit appropriate flexibility in site design; however, they should be as specific as possible regarding their use under various conditions.

Driveway regulations and design standards should be administered in coordination with subdivision and zoning ordinances. A driveway ordinance should include the following:

1. A statement on the need and purpose of the ordinance.
2. A declaration of the authority vested in the local government to establish driveway regulations.
3. Implementation procedures (i.e., permit requirements).
4. Policies and procedures for granting exemptions and variances.
5. Inspection policies and procedures.
6. Field change policies.
7. Policies on accommodating future changes in land use, traffic conditions, etc. (the legal rights and responsibilities of the local governing body to modify access conditions as needed).

In addition to establishing basic criteria in ordinance form, it is recommended that local agencies develop a supplemental set of design standards and guidelines (including typical layouts) for use in the actual design process. These standards and guidelines should be required by ordinance.

9.7 Procedures

9.7.1 Driveway Permits. Driveway regulations should be implemented within cities and counties through the issuance of driveway or curb-cut permits. A driveway permit is a legal document granting permission to construct and operate a driveway of a certain basic design at a given location.

Driveway permits in an urban area should be issued for a certain type of land use and for a specific site plan. A

change in the land use or in the site layout (e.g., building expansion) should void the driveway permit and require the submission of a new permit application.

9.7.2 Permit Applications. Driveway permit applications should contain sufficient information, when combined with the building permit and a site development plan, to allow the city or county to fully assess the adequacy of the proposed driveway design. Permit applications should include, as a minimum, the following:

1. The street or highway and land parcel on which the driveway(s) will be constructed.
2. The location and design of the driveway(s).
3. The date of the application and the proposed date of construction.
4. Notice of required assistance from the city or county.
5. A notice that the permit will be revoked if the driveway becomes a hazard or adversely affects traffic flow or if the land use changes.
6. A statement on who will perform the construction work and who will pay for the work, materials, etc.
7. The name of the landowner.

Driveway permits should be filed after review and approval of a site development plan. The site development plan should be a required part of the building and driveway permit applications. The site development plan must satisfy the following requirements:

1. It should be drawn to scale (1" = 50' or less).
2. It should show the dimensions, location, and design of all proposed driveways.
3. The location of any buildings or structures, either existing or proposed, should be shown.
4. The type of land use activity and the extent of site development (e.g., floor space) should be stated.
5. The parking lot with the proposed internal circulation pattern should be shown.

6. All existing or proposed gutters, storm sewers, manholes, fire hydrants, utility poles, service fixtures, etc. that may be affected by or that may affect driveway operations should be shown.
7. Any existing driveways or curb-cuts located on adjacent lots or lots across the street should be shown.
8. All of the geometric design features of the roadway itself should be shown, including the median, the number and width of travel lanes, the shoulder or parking lane, etc.
9. The distances to intersecting streets should also be shown.

9.7.3 Multiple Driveway Permit Applications. When more than one driveway is being requested for a single development along a major arterial street, the permit applicant should be required to submit a professionally prepared report justifying the need, describing the internal circulation and parking system, and identifying the impact of the development, even if only part of the site is being developed at the time. Also, the report should consider projected traffic growth for a 20-year period. The report requirement will discourage the indiscriminate placement of driveways on critical arterial streets.

9.7.4 Permit Application Review. The department issuing the driveway permits, as well as the permit review and approval process, will vary depending on local government structure. However, in all cases it is recommended that traffic engineering and planning personnel review the permit applications for all commercial, industrial and multi-family residential driveways and all driveways on arterial streets. It is also recommended that the traffic and planning staff work directly with the developer or builder in arriving at an acceptable driveway layout. For the review process to be efficient and effective, all parties must be aware of the procedures and requirements.

9.7.5 Typical Procedure. At the time a developer, builder, or land owner requests a building permit application, he or she is 1) informed of the requirements and procedures for obtaining the necessary driveway permit; 2) given a driveway permit application and a copy of the driveway ordinance and supplemental guidelines, if appropriate; and 3) encouraged to contact the traffic and/or planning department for assistance, if necessary. The individual is also informed of the requirement of a site development plan. It is recommended

that building and driveway permits be obtained from and filed in the same department.

The building and driveway permit applications and the site development plan are then circulated to the planning and traffic departments (and other departments as necessary) for review and approval. In some cities, department representatives meet periodically to review permit applications as a team.

If all departments approve the site development plan and the applications, the permits are issued and work can begin. Otherwise, the permits are denied and the applicant must modify the permits and/or site development plan or file an appeal.

9.7.6 Appeals. If a driveway permit application is rejected and it cannot be resolved by submission of a revised permit application (in other words, if the applicant is unwilling or unable to make the necessary changes), a formal procedure of appeal should exist. A typical appeal procedure might be as follows:

Upon initial receipt of a permit application, the permit would be reviewed by all affected departments. If a department required modification of the requested driveway(s), then the permit application would be channeled back to the initial office and the applicant would be informed of the problems. At this point, the applicant could meet with representatives of the department to try to resolve the problems. If the problems could be ironed out, the applicant would make the corrections, refile the permit, and it would be approved. If the applicant did not feel like the changes were warranted or practical, the applicant should have the right of appeal.

The appeals procedure can vary depending on the city or county. The most important thing, however, is to have a standard appeals procedure to promote consistency and remove chances for political influence in the final decision.

9.7.7 Permit Fees. It may be desirable to charge a fee for the filing of driveway permits. In some cities, fees are charged to cover the cost of actually reviewing and issuing the permits and inspecting subsequent construction. This approach is favored by those who feel it is unethical for general tax dollars to pay to regulate an individual

property owner's driveway. On the other hand, it can be argued that when driveways are regulated, the public is benefited, making the use of public tax dollars in paying for the issuance of permits and the inspection of construction a legitimate expenditure. Therefore, some cities charge no fee.

9.7.8 Performance Deposit. It is recommended that a performance deposit be collected from the construction contractor, developer, property owner, etc., at the time the driveway permit is issued. The deposit should be held to ensure that the driveway is located, designed, and constructed in accordance with the approved standard. After inspection, the deposit, less any inspection charge, would be returned to the individual.

9.7.9 Inspection. the inspection of driveways is a critical part of driveway regulation. The department responsible for issuing driveway permits, if possible, should do the inspection work. This will ensure maximum consistency and coordination. The inspection of driveways should include checking dimensions (i.e., width, driveway length, turning radius, etc.), the approach grade, the approach angle, sight distance, signing, channelization, pavement markings, pavement design, expansion joints, etc. In other words, all the critical aspects of driveway design and operation should be inspected for compliance with the approved site development plan and local construction standards.

It is necessary to inspect a driveway layout before it is actually constructed, so that mistakes can be corrected before they become costly to correct. An inspection should also be made after construction.

Inspection may need to be more intensive on critical driveways, such as commercial driveways on arterials. A traffic expert should inspect these driveways. For all driveways, it is imperative that the inspector be trained and knowledgeable in the areas of driveway design and operation and traffic flow.

9.7.10 Enforcement. If a driveway is not constructed according to its approved design or is operated improperly, then it is the responsibility of the city or county to enforce the needed modifications. One effective method of gaining compliance involves the use of a certificate of occupancy. Issuance of a certificate of occupancy is required in order to occupy a new, renovated, or expanded structure. If a driveway is not constructed to standards, the certificate of occupancy is denied or revoked until the

necessary modifications are completed. This particular procedure, combined with stiff fines on the landowner for each day the problem goes uncorrected, is a good deterrent to constructing substandard driveways.

Another enforcement tool (mentioned earlier) is the performance deposit. If a driveway is not constructed or operated as approved, the performance deposit is retained until the necessary changes are made. The deposit can be used, if needed, to finance the modifications.

9.7.11 Accommodating Change. Within ordinances, cities should establish the right or require property owners to make changes in their driveways when the land use or traffic characteristics along the street change significantly. These access modifications should be initiated by the city or county engineer or the traffic engineer. Generally, requiring a landowner to make driveway changes will be a major effort so a standard procedure for initiating and making these changes should be well established.

9.8 Summary

Access to property is an important right for a landowner. Uncontrolled access, however, can cause serious problems for operations on adjacent streets. In seeking the proper balance between private rights and public welfare, basic traffic engineering criteria should not be sacrificed. This chapter has presented a set of guidelines for both design and implementation that can form the basis for an effective program of driveway access control.

9.9 Bibliography

Since there is so much interest in the design, regulation, and operation of driveways, some references giving a more detailed treatment of items most applicable to the Indiana small city and rural environment are listed in this section. For the most part, they have been selected from the extensive bibliography in Volume 1 of the Texas Transportation Institute report [31].

1. Faulkner, Robert Allen. Evaluation of Current Standards and Policies Concerning Access Driveways. Masters Thesis, Civil Engineering Department, Texas A&M University. January 1969, pp. 1-93.

2. McGuirk, William W. Evaluation of Factors Influencing Driveway Accidents. Joint Highway Research Project, File 8-S-16, Project C-36-59P. May 3, 1973, pp. 1-130.
3. McGuirk, William W. and Satterly, Gilbert T., Jr. Evaluation of Factors Influencing Driveway Accidents. Transportation Research Record 601, 1976, pp. 66-72.
4. McReynolds, Marshall B. and Hanna, John T. Driveway Control in Richmond, Virginia. Traffic Engineering, October 1950, pp. 11-12.
5. Marconi, William. Driveway Accidents in San Francisco. Traffic Engineering, January, 1967, pp. 45-47.
6. Schoppert, David W. Traffic Control and Roadway Elements - Their Relationship to Highway Safety. The Automotive Safety Foundation, 1963, pp. 65.
7. Staffield, Paul R. Accidents Related to Access Points and Advertising Signs. Traffic Quarterly, January 1953, pp. 59-74.
8. Stover, V. G. Regulation of Access Along Arterials. Texas Transportation Researcher, TTI, October 1969, pp. 3-5.
9. Stover, V. G. and Goodknight, J. C. Well Designed Access Driveways Improve Traffic Operation and Commerce. Texas Transportation Researcher, TTI, July 1969, pp. 8-11.
10. Stover, Virgil G., Adkins, William G., and Goodknight, John C. Guidelines for Medial and Marginal Access Control on Major Roadways. NCHRP 93, 1970, pp. 1-117.
11. A Policy and Standards for Entrances to State Highways. Public Works, December 1966, pp. 68-70.

10. SITE CHARACTERISTICS

Site circulation planning must be a cooperative and creative work that coordinates the different aspects of the site, like parking facilities, internal circulation, configuration, and site access points [18].

Site characteristics have an impact on the access and internal circulation system. Desired characteristics include ample size, regular shape, reasonably level terrain, adequate frontage, and access from nearby roads. Section IV in Appendix A summarizes the principles involved for commercial developments and Table A.8 in the same appendix gives typical on-site storage space requirements.

10.1 Site Access Guidelines

Figure 10.1 is an example of a good site access plan. It includes the following points:

1. Access points are spread along several streets to disperse traffic more evenly.
2. Provision of directional lanes into the development from the road permit simple signal controls and coordination.
3. Islands separate opposing directions of travel at multi-lane access points.
4. Circulation roads provide for more on-site storage if they are set back about 150 feet from the artery.
5. Parking areas and access points are connected by "ring roads". Canoe shaped islands prevent cars from entering the parking lots directly. Refer to Section IV of Appendix A for more details.
6. Parking space is "compartmentalized", by means of islands and landscaping. The aisles are 90 degrees to the building block, thereby facilitating pedestrian movements.
7. The building block is placed on the same axis as the road. This results in 90 degree intersections between parking aisles and adjacent roads.
8. The building is about 500-600 feet from the roadway, and thus allowing about 300 feet for parking.
9. Service areas are removed from the primary parking areas.

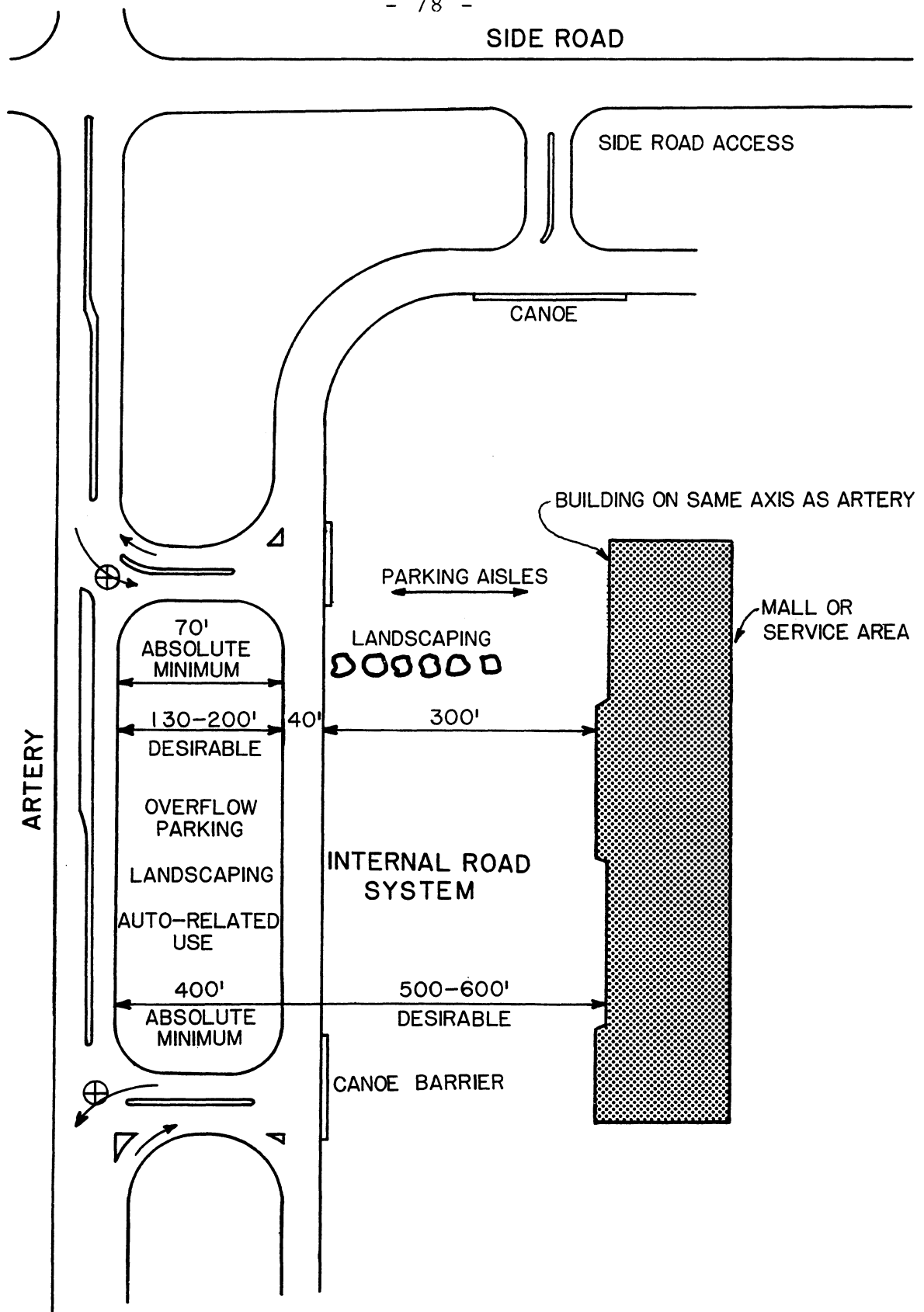


FIGURE 10.1 [19]
SITE ACCESS CONCEPT

11. RESERVOIR SPACE

Drive-in service facilities generate high volumes of traffic and require drivers to remain in their vehicles while being served or until service begins. The design of such facilities should provide for the safe and efficient movement of traffic on public rights-of-way, by providing adequate off-street reservoir space for waiting vehicles, and by minimizing the probability that a queue of waiting vehicles might extend into the roadway. The following elements are important in the design of such reservoir spaces [15]:

- i. In addition to using the critical hourly volume to measure the peak demand, the 5-minute, 15-minute or 30-minute demand is necessary because peaking within the design hourly volume is critical for such developments.
- ii. The needed reservoir area is a function of the demand volume, number of service facilities and the service time per facility. The service times can be measured at existing facilities with similar functions and similar geometrics.
- iii. The service time includes the time for the vehicle to maneuver into the service area after entering the development, and the time it takes to obtain service. The former time is related to the geometrics of the facility, especially the width of lanes, travel pattern and the radius of the final approach turn. Wide lanes and flat approaches shorten the entering time. It is recommended that 11-12 feet approach lanes, as straight as possible be used. For tight turns, a 30-foot outside radius is the practical minimum. If a turn exceeds 60 degrees, lanes within the turning area should be 13 feet wide.

If the facility is on a high-volume road, it is suggested that sufficient space be left between the curb lane and the facility to preclude backups. Two or three spaces beyond each window is usually sufficient. As a general rule, reservoir space must be maximized, and exiting lanes should be made as short as possible.

The following guidelines should be used in determining reservoir space [15]:

1. Study a similar facility and estimate demand for the site in question.

2. Assuming a service rate of 30 VPH per window, calculate the number of windows needed. If cars can be served at a rate of 40 VPH or more, and the average demand in the peak hour does not exceed 35 VPH per window, a waiting area for 20 vehicles will not overflow more than five percent of the time. If the peak hour demand is increased, the waiting area will certainly increase. See references [16, 18] for more details.

12. FRONTAGE ROADS

A frontage road is a secondary road located on one or both sides of a major route for service to abutting property and adjacent areas. Its use is warranted where the access points from the major route are to be minimized. They are most effective with expressways and freeways where they can collect and distribute traffic between designated points of access and provide access to abutting property having no other available access.

12.1 Operational, Safety and Design Considerations

Consideration should be given to one-way frontage roads where the proposed development is adjacent to a major street with at-grade intersections. This is preferred over the two-way frontage roads because of the potential confusion created by the visible presence of traffic on the adjacent major route. Two-way frontage roads, however, may be acceptable if this "visible presence" is eliminated using vision controls like fenced screening, walls or landscape. On the other hand, one-way streets are more conducive to higher speeds, which generally may be undesirable on frontage roads.

The separation between frontage roads and major routes should be sufficiently wide to minimize the effect of approaching traffic, particularly headlight glare. The recommended minimum is 8 feet [30].

Connections between major routes and frontage roads are important elements of the design of such facilities. Figures 12.1 and 12.2 show typical frontage road connections.

12.2 Economic Considerations

The frontage road is justifiable if the costs of furnishing the frontage road are lower than the cost of providing access by other means and if the frontage road intersection with cross streets can be located for efficient movement of cross street traffic [30].

12.3 Warrants

For divided highways, frontage roads may be warranted if speeds of 40 to 55 mph are anticipated, a high level of development (more than 60 driveways per mile) is present, or if traffic volumes exceed 20,000 ADT. On expressways, a frontage road is warranted if the number of access openings on one side of the expressway exceeds three in one-quarter mile.

Along freeways, frontage roads can be used to accomplish the following [30]:

- i. Retain continuity of the major or local street system.
- ii. Serve local traffic that otherwise might use the freeway.
- iii. Reduce the unreasonable circuitry of travel which would be incurred due to freeway construction without a frontage road.
- iv. Provide access to abutting parcels where suitable alternative access does not exist.

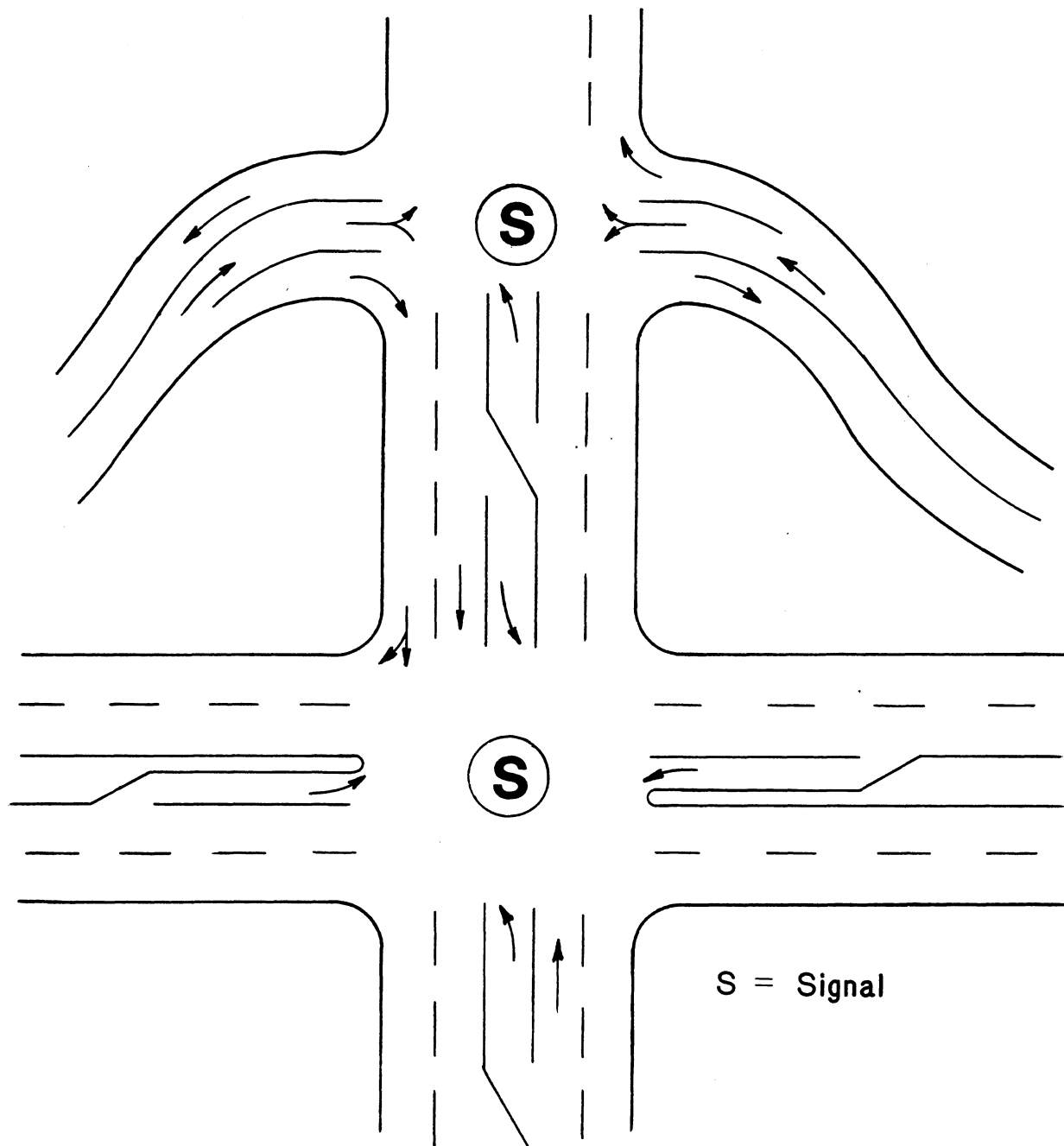


FIGURE 12.1 [30]
HIGH VOLUME PARALLEL FRONTAGE ROAD
CONNECTION TO MAJOR CROSS STREET

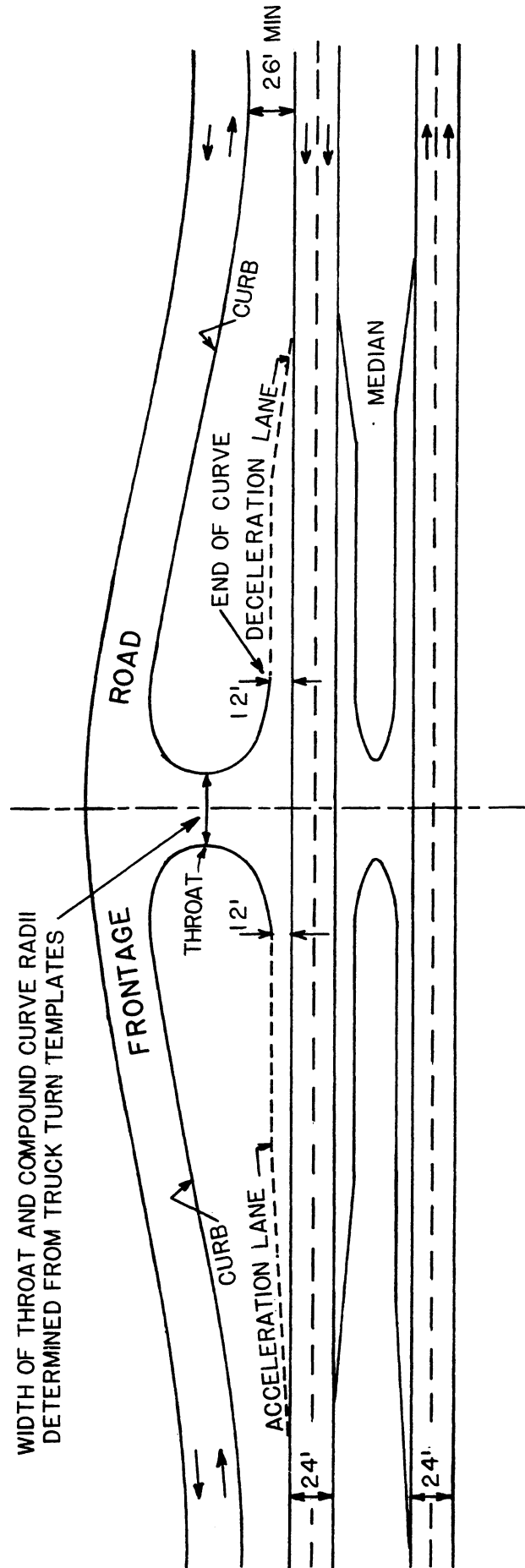


FIGURE 12.2 [3G]
TYPICAL BULB CONNECTION FOR
LOW VOLUME FRONTAGE ROAD

REFERENCES

1. Azzeh, J.A., Thorson, B.A., Valenta, J.J., Glennon, J.C., Wilton, C.J., Evaluation of Techniques for The Control of Direct Access to Arterial Highways, Report No. FHWA-RD-76-85, Federal Highway Administration, August 1975.
2. American Association of State Highway and Transportation Officials, Policy on Design of Urban Highways and Arterial Streets, Washington, D.C., 1973.
3. American Association of State Highway and Transportation Officials, Policy on Geometric Design of Rural Highways, 1965.
4. American Association of State Highway and Transportation Officials, A Policy on Geometric Design of Highways and Streets, 1984.
5. Baughman, C.B., Warrants For Location And Design Of Local Service Roads, Joint Highway Research Project, School Of Civil Engineering, Purdue University, October 1975.
6. Bochner, B.S., Regulation of Driveway Access to Arterial Streets, Presented to The Institute of Transportation Engineers, 48th Annual Meeting, Atlanta, Georgia, August 1978.
7. Box, P.C., Chapter Five, Driveways, Traffic Control and Roadway Elements-Their Relationship to Highway Safety/Revised, Highway Users Federation for Safety and Mobility, 1970.
8. Box, P.C., "Driveway Accident and Volume Studies", Public Safety Systems, May/June 1969.
9. Box, P.C., "Analysis of Traffic Impact for New Developments", Public Works, February 1981.
10. Box, P.C., "Signal Control of High Volume Driveways", Municipal Signal Engineer, November/December 1965.
11. Federal Highway Administration, General Framework for Implementing Access Control Techniques, Vol. I, Technical Guidelines for The Control of Direct Access to Arterial Highways, Report No. FHWA-RD-76-87.
12. Federal Highway Administration, Detailed Description of Access Control Techniques, Vol. II., Technical Guidelines for The Control Of Direct Access to Arterial Highways, Report No. FHWA-RD-76-87.

13. Flora, J.W., Keitt, K.M., Access Management for Streets and Highways, Federal Highway Administration, U.S. Department of Transportation, Report No. FHWA-IP-82-3, June 1982.
14. Frick, W.A., "The Effect of Major Physical Improvements of Capacity and Safety", Traffic Engineering, December 1968.
15. Institute of Transportation Engineers Technical Council Committee 5N-S, "Guidelines for Driveway Design and Location", Traffic Engineering, February 1973.
16. Institute of Transportation Engineers Technical Council Committee 5-DD, Guidelines for Planning and Designing Access Systems for Shopping Centers, Informational Report of the Institute of Transportation Engineers, Traffic Engineering, Jan/Feb 1975.
17. Institute of Transportation Engineers, Technical Council Committee 5-5, Guidelines for Urban Major Street Design, Institute of Transportation Engineers, Washington, D.C., May 1979.
18. Levinson, H.S., Planning and Design Techniques, Presented at The Workshop On Access Management, Technology Transfer Center, University of Connecticut, May 1984.
19. Levinson, H.S., "Why Manage Access?", Presented at The Workshop On Access Management, Technology Transfer Center, University of Connecticut, May 1984.
20. Manual on Uniform Traffic Control Devices for Streets and Highways, Federal Highway Administration, U.S. Department of Transportation, 1978.
21. Manual on Uniform Traffic Control Devices for Streets and Highways, Federal Highways Administration, U.S. Department of Transportation, 1971.
22. Marks, H., Traffic Circulation Planning for Communities under Commission from the Motor Vehicle Manufacturers, April 1974.
23. Midwest Research Institute, Technical Guidelines for The Control of Direct Access to Arterial Highways, Volume 2, August 1975.
24. Stover, V.G. et al, Guidelines for Median and Marginal Access Control on Major Roadways, Transportation Research Board, National Cooperative Highway Research Program Report No. 93, 1970.

25. Transportation Planning, Design and Policy Standards for Development Review, Lakewood, Colorado, March 1983.
26. Uckotter, D.A., Analysis of Motor Vehicle Accidents at Commercial Driveway Locations, Report 74-9, Joint Highway Research Project, Purdue University, June 1974.
27. USASI Standard A117.1-1961, American Standard Specifications for Making Buildings Accessible to And Usable by The Physically Handicapped.
28. Winkle, S. Van, "When Evaluating Access, Consider "T" Intersections", Institute of Transportation Engineers Journal, Volume 52, No.3, March 1982.
29. Wolfe, J.A., Barry, T.F., Proposed Median Revisions-State Road 809 (Military Trail), District 4, Florida Department of Transportation, May 1982, unpublished.
30. Institute of Transportation Engineers, Guidelines For Control Of Access On Major Routes, unpublished draft report of Technical Committee 5B-8, August 1984.
31. Richards, Stephen H., Robert Eckols, and Conrad L. Dudeck, Guidelines for Driveway Design and Operation, Texas Transportation Institute, 1980, 3 volumes.
32. Institute of Transportation Engineers, Guidelines for Driveway Design and Location, Report of Committee 5B-13, 1985.

APPENDIX A: GENERAL RECOMMENDATIONS

I. General

Some basic information to supplement that appearing in the body of the manual is presented in this appendix. For the most part, the figures and tables in this appendix

- have been cited in the body of the manual, and
- provide alternatives to the recommendations in the body of the manual, or
- cover situations and conditions different from those in the in the body of the manual.

However, it is suggested that the reader look over the material in this appendix to determine its value, since some of it is not directly referred to in the manual's chapters. It should again be stressed that these design values are guidelines, and the permit engineer can adjust these values as required to handle expected traffic conditions.

Table A.1: Recommended Residential Driveway Spacing

	Urban	Rural
From Property Line, feet	0	0
From Street Corner, feet	5	10

(1) Measured along the curb or edge of pavement from the roadway end of the curb radius. See Figure A.1.

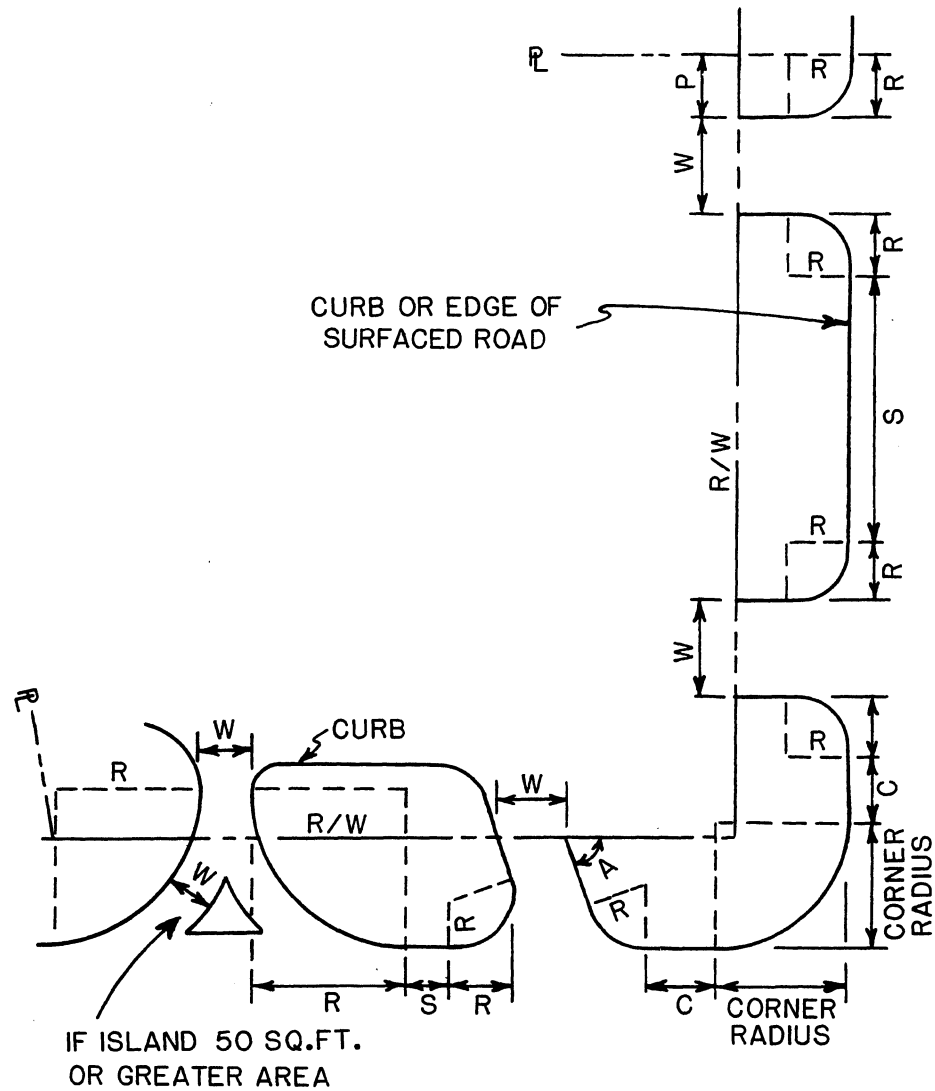


FIGURE A.1 [15]
DRIVEWAY DIMENSION MEASUREMENTS

Table A.2 [18]
Driveway And Access Road Guidelines (Suburban Conditions)

	Type of Driveway			
	Minor	Major		
Item	Minimum Use, e.g., Single Dwelling Unit	Low Volume: 0-500 VPD, e.g., 50 Condos, 100-room Motel	Medium Volume: 500-1500 VPD, e.g., Drive-in Restaurant	High Volume: Over 1500 VPD, e.g., Shopping Center
Distance from Intersection, feet				
Minimum	25	25	50	400-1200
Desirable	50	50	100	600-800
Spacing Between Driveways, feet				
Minimum	20	20	100	300-400
Desirable	60	60	300-400	600-800
Driveway Width, feet				
Minimum	8	11 ft per lane	11 ft per lane	
Maximum	16	36 ft., undivided two-way drive	4 lanes one-way divided drive	
Curb Radii, feet				
Minimum	10	15-20	25-50	
Maximum	5	25-50	25-75	
Holding or Storage Area Length, feet				
Minimum	20	20-40	50	
Desirable	20	40-60	100-200	
Driveway Grades, percent				
Maximum Grade	5-6	5-6	5-6	
Maximum Grade Change	3-6	3-6	0-3	
Angle at Street, degrees				
	45-90	45-90	60-90	

Table A.3 [23]

Minimum Driveway Spacing

Arterial Speed (mph)	Minimum Separation (feet)
20	85
25	105
30	125
35	150
40	185
45	230

Driveways: The above values can be used for two-way driveways. Distances between adjacent one-way driveways with the inbound drive upstream from the downstream drive can be one-half the distances shown above.

Table A.4 [30]

Recommended Median Width Criteria for Major Roadways

Function	Urban (feet) Minimum	Desired	Rural (feet) Minimum
Separation of opposing traffic streams	4	10	20
Provide pedestrian refuge and room for signs and appurtenances.	6	14	14
Provide storage of left-exiting vehicles.	16	20	20
Provide protection for vehicle crossing through lanes.	25	30	30
Provide for U-turns, inside lane to outside lane. (4-lane facilities)	45	45	45
Provide for U-turns, inside lane to outside lane. (6-lane facilities)	33	33	45
Provide for U-turns, inside lane to inside lane. (4-lane facilities)	56	60	60

Table A.5 [30]

Minimum Distances Between Median Openings

Arterial Speed (mph)	Minimum Distance (ft)	
	Absolute Minimum	Desirable Minimum
25	140	290
30	190	370
35	240	460
40	300	530
45	360	670
50	430	780
55	510	910

Table A.6 [30]

Lengths of Median Openings At Intersections

Median Width (ft)	Minimum Length of Median Opening ((ft)		
	Passenger Car	Single Unit Truck	Tractor- Trailer Combinations
6	60	76	93
8	53	68	85
10	47	62	77
12	43	58	73
16	**	50	64
20	**	44	57
24	**	**	51
28	**	**	45
32	**	**	**

** : Minimum length of opening is 40 ft.

Table A.7: Typical Tapers [17]

Type of Taper	Equation
Approach	$L = WS^2 / 60$
Bay	$L = WS / 3$
Combined	$L = WS^2 / 60$

S = Speed in MPH

L = Length in feet

W = Width of offset in feet

Note: With closely spaced bays, shorter tapers may be advisable to improve length of storage lanes. Where storage length would otherwise be insufficient, very sharp approach and bay tapers may be used.

II. Unsignalized Major Driveways

An unsignalized major driveway at grade may be considered to be similar to an unsignalized intersection. It was found that left turn storage lanes were justified for extremely low volumes. As shown in Figure A.2, a left turn volume of 50 vph from a four-lane highway facing an opposing volume of 300 vph for example, would justify a left turn bay 50 feet in length. If the opposing volume was 1100 vph, a bay length of 100 feet would be needed.

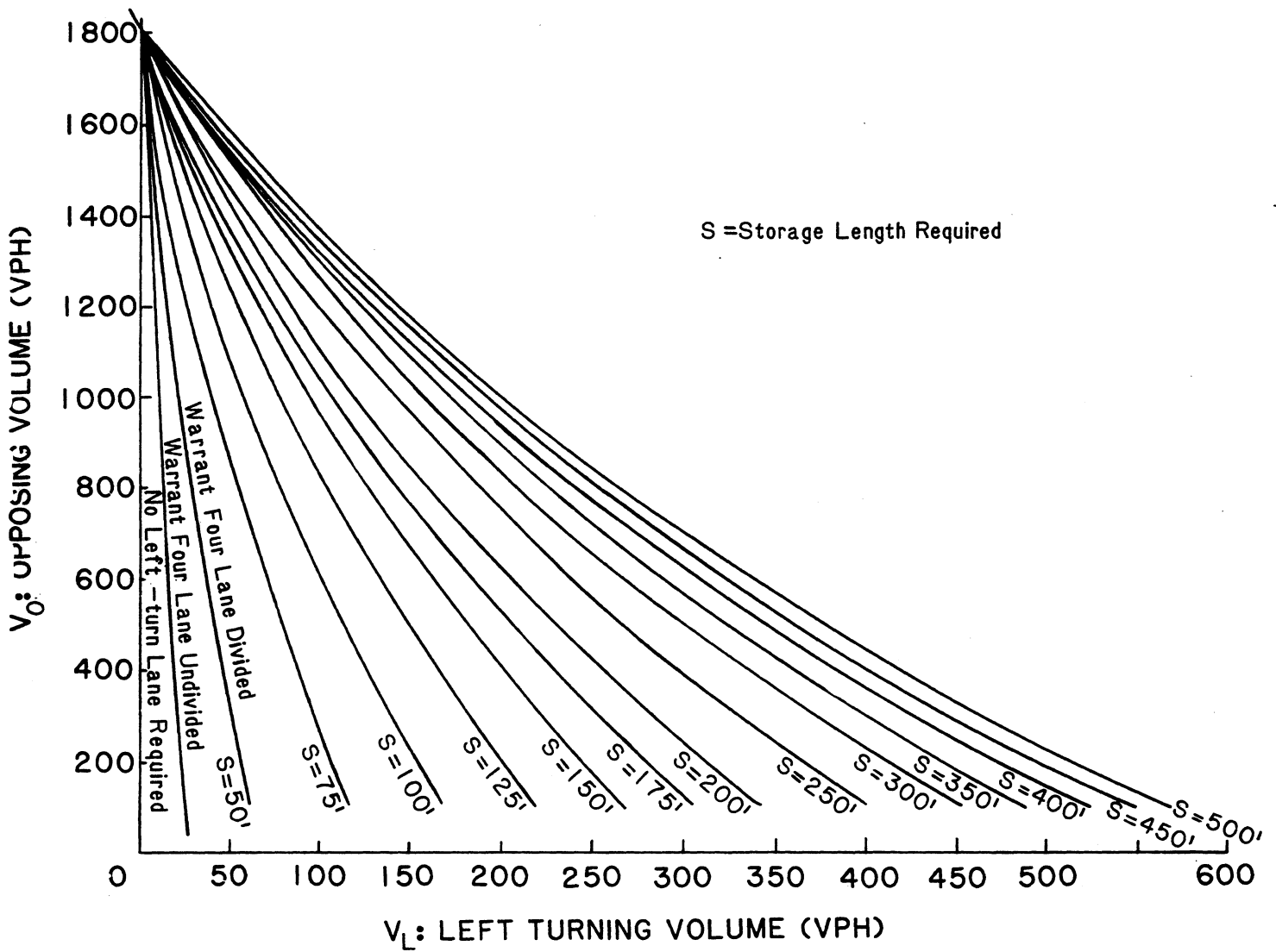


FIGURE A.2 [15]
WARRANTS FOR LEFT TURN SHORTAGE LANES ON FOUR-LANE,
AT-GRADE, UNSIGNALIZED HIGHWAYS

Table A.8 [18]

Typical On-site Storage Space (Desirable Conditions)

Use	Units	Cars to Store		
		Local	Collector	Arterial
Low Rise Apartments	80-160	1	1	1
High Rise Apartments	0-300	1	1	2
Condominium; planned unit development	240-300	2	3	5
Quality Restaurant	15-30 MSF [*]	1	1	2
Drive-in Restaurant	5-7 MSF	3	4	6
Motel	0-150 rooms	1	1	2
Office Park	150-300 MSF	5	10	20
Office	150-300 MSF	3	7	14
Light Industry	200-300 MSF	2	3	6
Discount Store	75-100 MSF	2	3	7
Shopping Center	250-500 MSF	7	15	30
Drive-in Bank	10-20 MSF	2	2	4
Supermarket	40-50 MSF	1	3	6
Medical Clinic	0-100 employees	1	1	2

* "MSF" stands for "thousands of square feet".

Table A.9 [23]

Cost-Effective Techniques To Preserve Roadway Capacity And Safety

Technique	Comment
<u>Capacity</u>	
a) Provide two driveway exit lanes rather than one.	a) Driveway ADT over 1000
b) Provide additional driveway.	b) Driveway ADT over 5000
c) Provide left-turn lane on arterial.	c) Conditions vary.
d) Provide left-turn deceleration lane.	d) 35 mph, 40 or more peak-hour right turns
e) Provide continuous right-turn lane.	e) 35 mph, 20 percent right turns
f) Provide direct access only from frontage roads.	f) 40 mph, 20,000 ADT, short frontage
g) Signalize driveway intersection.	g) See "Manual on Uniform Traffic Control Devices".
<u>Safety</u>	
a) Prohibit parking on arterial streets, provide adequate driveway entrance width, provide minimum 15 mph turn speed.	a) All locations
b) Provide two driveways with limited turns rather than two standard driveways, or provide two one-way driveways rather than one two-way driveway.	b) "T" driveway intersections, 40 left turns per hour in one direction, 200-foot minimum frontage
c) Channelize driveways or install median to prohibit selected movements.	c) Fewer than 100 turns per day, high driveway densities
d) Ensure adequate sight distance.	d) See AASHTO "Policy on Geometric Design of Rural Highways".
<u>Capacity and Safety</u>	
a) Maintain minimum corner clearance.	a) 50 feet or more.
b) Provide access from collector street instead of access from arterial street.	b) Corner residential parcels, corner parcels with more than one driveway
c) Consolidate access to, and connections between, adjacent properties.	c) Frontages too short to permit minimum spacing
d) Provide adequate internal circulation and parking space.	d) Always

III. Minimum Distance from Major Intersections

A minimum distance requirement is established for driveways with left turn channelization, from a major intersection also having left turn bays. This distance is established according to whether the driveway is on the approach or departure side of the intersection with respect to the left turn lane.

1. The driveway is on the approach side of intersection:

Consider the situation where a north-south route is to have a northbound left turn bay to a driveway. Assume that a bay 100 feet long is required. A major intersection is located to the north of the driveway, and requires a left turn bay of 200 feet with 120-foot taper. The closest permissible location for the driveway is then 320 feet from the intersection, as shown in Figure A.3 (a).

2. The driveway is on the departure side of intersection.

If the same driveway is located to the north of the intersection, however, the minimum permissible distance for a northbound left turn driveway, would equal the length of the left turn storage bay for the southbound traffic at the intersection (200 feet), plus the taper length (120 feet), plus the 100-foot left turn bay for the major driveway (Figure A.3 (b)). These lengths add up to a minimum permissible distance of 420 feet from the major intersection.

This example is a clear indication that driveways should be designed for the particular traffic characteristics anticipated and that upstream and downstream factors affecting a driveway location should be considered for each situation separately.

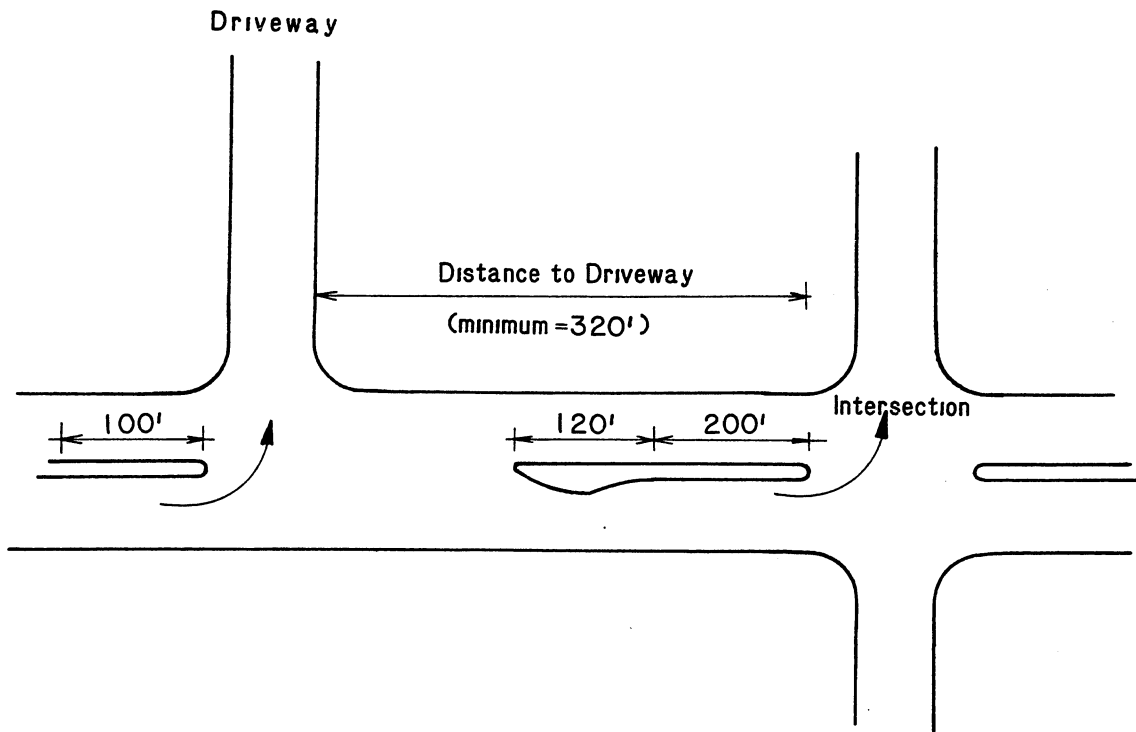


FIGURE A.3(a) DRIVEWAY ON THE APPROACH SIDE OF INTERSECTION

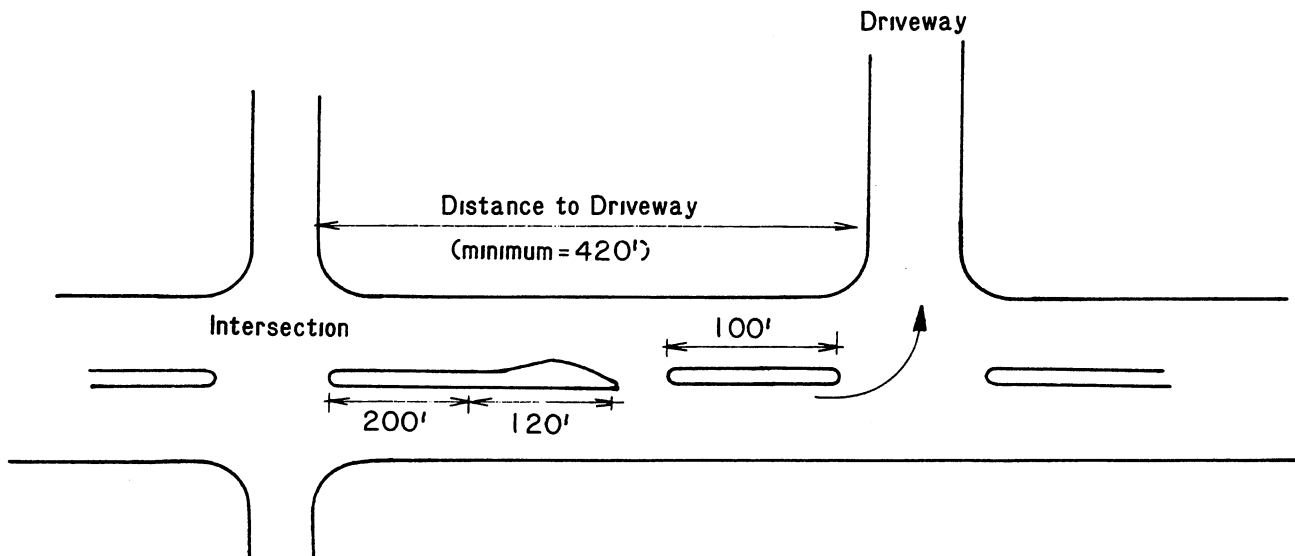


FIGURE A.3(b) DRIVEWAY ON THE DEPARTURE SIDE OF INTERSECTION

IV. Transportation Planning Principles for Commercial Developments [18]

1. Site Characteristics

- a. Site selection should avoid irregular shapes, difficult terrain, and unusual building configurations.
- b. The acreage should exceed 0.7 times the gross leaseable area in thousands of square feet.
- c. Fit the site plan to the terrain; take advantage of opportunities for various levels.
- d. Fit buildings to the same shape of the site. It is desirable to orient buildings to the site, wherever possible. A rectangular building configuration is desirable on a rectangular site. The building axis should be the same as that for the site boundary roads. Note that this objective conflicts with the objective of maximizing exposure of buildings from approach road.

2. Approach Road Access

- a. Adequate site frontage on surrounding streets helps facilitate access.
- b. Equalize the distribution of shopper traffic on approach and boundary roads.
- c. Maximize entry opportunities. It is desirable to provide two choices to enter from principal approaches.
- d. Major approach routes should lead to corners of site. This will make it possible to distribute traffic to site entrances.
- e. Coordinate site access points with the location of highway intersections, and driveway openings on opposite sides of streets. Remove access points from major street intersections, and locate them to facilitate signalization.

3. Site Access Points

- a. Locate and design access points to facilitate signalization and allow effective signal coordination. Avoid complex multi-phase intersections. (Directional designs are sometimes used to separate heavy conflicting left turns into and out

of a site).

- b. Provide "reserve capacity" for variances in estimates.
- c. Multiple left turn lanes may be desirable for entering traffic. Multiple lane exits are desirable.
- d. Provide a minimum 50 feet radius at access points. (25 feet radius is absolute minimum).
- e. Provide median islands and curbs at access points to large activity centers.
- f. Access drives that are signalized should have separate lanes for right and left turns.

4. Internal Circulation

- a. Provide adequate storage areas on approaches to boundary roads.
- b. The size of site, intensity of development, and location of parking may require a special distribution roadway within the site. This "ring road" should be two-way and located about 300-400 feet from stores. It can be up to 45 feet wide.
- c. Access road junctions with the ring road should be designed as "T" intersections. This is achieved by placing a "canoe-shaped" island opposite the road, to disperse entering traffic and to keep it from indiscriminately cutting across parking areas.
- d. Minimize through circulation along buildings in larger centers. Store front roads should be no wider than 30 feet to discourage illegal parking and conflicts with pedestrians.
- e. Separate pedestrian, auto, and service vehicle movements as much as possible.
- f. Provide facilities for public transport. Normally, these can be incorporated into the road system.

5. Parking

- a. Equalize parking on all sides of the buildings. In addition, the distribution of parking should be keyed to the relative importance of all sides of

the site.

- b. Compartmentalize parking lots. Interconnect all parking areas by the internal circulation system.
- c. Parking should be adequate in quantity and designed to facilitate maneuverability. Where possible, parking should be located to serve multiple uses (e.g., daytime employees, evening visitors).
- d. Use parking aisles as walkways to stores.
- e. Provide most parking spaces within 300-400 feet of buildings.
- f. Parking must be visible from approach roads.
- g. Avoid having motorists enter parking areas only from roadway adjacent to buildings.
- h. Large stores may need facilities for deliveries. These are normally provided on the site. Truck tunnels are limited to very large centers because of their costs. Small stores, other than food stores and restaurants do not need any special loading facilities.
- i. Use landscaping to compartmentalize parking and break up large masses of pavement.

APPENDIX B: SAMPLE ACCESS CONTROL ORDINANCE

The enclosed access control ordinance was obtained from the City of Lafayette, Indiana. The purpose of this sample ordinance is to familiarize the responsible authorities with the issues involved in preparing similar documents. Several of the figures, sketches, and tables in the Lafayette ordinance have been omitted, but these are similar to those found in the body of this manual on a given topic. Before preparing such a ordinance, the responsible authorities in a city or county should seek the advice of their legal counsel. Permission to print this document was obtained from the City of Lafayette.

SAMPLE ORDINANCE

ACCESS STANDARDS
FOR
DRIVEWAY CONNECTIONS
TO
PUBLIC STREETS AND ROADS

INTRODUCTION

The purpose of this manual is to establish standards, criteria and guidelines subject to variation, based on engineering judgement so as to provide a basis for the review, and approval of all requests for access to public streets and thoroughfares.

It is the scope of this manual to cover in detail as many conditions as possible regarding various types of commercial, industrial, schools, churches, and residential access points to Public Highways - regardless of the type of access control exercised. The intent is to consider all types of access for urban, rural, or intermediate conditions, within the jurisdiction of the City of Lafayette, (hereinafter referred to as "the City").

The efficiency, and safety of a roadway facility, with limited access control, or without access control, depends greatly on the amount, and character of roadside interference. Most of this interference originates in vehicular movements to the from residential, commercial, and industrial developments along the facility.

The rights of abutting property owners for access is realized, but it is necessary for the City to establish controls regarding the number, location and geometrics of access points. This is necessary to maintain good operational characteristics on the facility, and to provide adequate safety features for the expeditious movement of people, and goods.

Highway interference resulting from excessive roadside development and uncontrolled driveway connections precludes the orderly, and safe movement of traffic in and out of private properties, and therefore, results in poor levels of service, increased hazards, and early obsolescence of the highway.

The necessary regulations, and geometrics of access points are very closely associated with traffic volumes, and operations, rights-of-way, land use and zoning control.

It is understood that commercial, and industrial growth within an expanding metropolitan area is inevitable. Therefore, it is necessary to provide access to these concerns in accordance with a well developed plan, as compatible as possible with the adjacent highway facilities, as it can easily be shown that traffic congestion adversely affects conditions for transacting business, produces accidents, interference with the effective operation of fire and police forces, and, in general, reduces the enjoyment of many

phases of urban life, and activity.

DEFINITIONS

ACCESS CONTROL (LIMITED) Those facilities where the right of owners, or occupants of abutting land, or other persons, to access, light, air, or view in connection with a highway, street, or roadway, is fully or partially controlled by the Responsible Authority.

ACCESS CONTROL (FULL) The access is controlled to such a degree that, no access will be permitted directly to the roadway from abutting property. The physical means of access shall be limited to interchange ramps, approaches, or other facilities located on public right-of-way at points designated by the Responsible Authority for specific entrance to or exit from the facility by the general public.

ACCESS CONTROL (PARTIAL) The access is controlled to such a degree that public access will be restricted to interchange ramps, at-grade intersections, approaches, or other facilities located on public right-of-way. Private driveways may be permitted at locations designated by the Responsible Authority solely for residential, or agricultural purposes, when so agreed, or stipulated with the property owner, when access rights are required. Any permit for such an entrance will show the limiting use. No direct access for commercial, or industrial use will be allowed. All other access for abutting property will be as indicated for Full Access Control Facilities. Median opening for U-turns for public use may be provided in accordance with established criteria.

ACCESS CONTROL (NORMAL) The rights of abutting property owners of access to the public roadway are recognized. On these facilities, entrances to the roadway will be allowed for abutting property, providing such access points comply with the standards, and regulations, established by the Responsible Authority. Entrances to the roadway will be allowed for abutting property, providing such access points comply with the standards, and regulations established by the Responsible Authorities.

APPROACH PAVEMENT - Portion of roadway adjoining the traveled way - include tapers, for recovery lane, deceleration, speed change, turning movements, or other purposes supplementary to the through traffic movement. The auxiliary lane may be existing or proposed to be constructed by the applicant.

CHANNELIZATION - The separation of conflicting traffic movements into definite paths of travel by use of pavement markings, raised island, or other suitable means to facilitate the safe, and orderly movement of traffic.

CITY OR CITY AUTHORITIES - Shall mean Traffic Engineer, Traffic Commission and/or Board of Works for the City of Lafayette, Indiana.

COMMERCIAL - Shall mean the purchase, sale, or other transaction involving the handling or disposition (other than that included in the term "Industry" as defined herein: of any article, substance, or commodity for profit or a livelihood including in addition, operation of automobile or trailer courts, tourist courts, and motels, public garages, office building, offices of doctors, and other professionals, outdoor advertising signs, and structures, public stables, recreational, and amusement enterprises conducted for profit, shops for the sale of personal services, places where commodities, or services are sold, or are offered for sale, either by direct handling of merchandise, or by agreements to furnish them, but not including dumps and junk yards.

DESIGN SPEED - A speed determined for design, and correlation of the physical features of a highway which influence vehicle operations. It is the maximum safe speed that can be maintained over a specified section of the highway when conditions are favorable, so that the design features of the highway govern.

DESIGN VOLUME - A volume determined for use in design, representing traffic expected to use the facility. Unless otherwise stated, it is an hourly volume.

DIVIDED HIGHWAY - A highway with separate roadways for traffic in opposite directions.

DRIVEWAY - Every way, or place not in the right-of-way of any public highway and which is used for vehicular traffic.

ENTRANCE - The connecting line of the driveway and the approach.

HIGHWAY, STREET OR ROADWAY - A general term denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way. Recommended usage: in urban area - roadway or street; in rural area - highway or road

INDUSTRIAL - shall mean the manufacture, fabrication, processing reduction, or destruction of any article, substance, or commodity, or any other treatment thereof in such a manner as to change the form, character, or appearance thereof, and including storage elevators, truck storage yards warehouses, wholesale storage, and other similar types of enterprise.

MEDIAN - The portion of a divided highway separating the traveled ways for traffic in opposite directions.

MEDIAN LANE - A speed-change lane within the median to accommodate left-turning vehicles.

MEDIAN OPENING - A gap in a median to provide for crossing and turning traffic.

MULTI-RESIDENTIAL - shall mean a building or buildings designed, and used for occupancy by three (3) or more families, all living independently of each other, and having separate kitchen, and toilet facilities for each family.

OPERATING SPEED - The highest overall speed at which a driver can travel on a given highway under favorable weather conditions, and under prevailing traffic conditions without at any time exceeding the safe speed as determined by the design speed on a section by section basis. On posted sections of highways and streets, the properly posted speed can be considered the operating speed.

PARKING CAPACITY - Maximum number of parking spaces available within the proposed facility having clear access to each space.

PERMIT - shall mean an authorization to construct an access driveway of a specified class granted by the local governing agency upon application, and in accordance with this ordinance.

PERMITTEE - Shall mean the applicant for the permit to whom the Board authorizes such permit.

RESIDENTIAL - Shall mean a detached building, designed or used exclusively for occupancy of one or two families, and having kitchen, and toilet facilities for each family.

RESPONSIBLE AUTHORITY - The governmental body, group or department with jurisdiction and responsibility for the Planning, designing, maintenance and policing of the indicated highway, street, or roadway.

RIGHT OF ACCESS - The right of ingress to a highway from abutting land and egress from highway to abutting land.

RIGHT-OF-WAY - A general term denoting land, property, or interest therein, usually in a strip, acquired for, or dedicated to street, roadway, or highway purposes to include any additional right-of-way as designated in the Master Plan of the responsible planning agency.

ROAD - (See Highway).

SITE - Shall mean one area consisting of one, or more, contiguous lots, or parts of lots which is to be used as one consolidated area.

SITE DISTANCE - The length of unobstructed view required by a motorist entering the traffic stream from a stopped position with the front of the bumper five (5') feet from the edge of the traveled way.

SETBACK LINE - A line outside of the right-of-way, established by public authority, on the highway side of which the erection of buildings or other permanent improvements is controlled.

SPEED-CHANGE LANE - An auxiliary lane, including tapered areas, primarily for the acceleration, or deceleration of vehicles entering, or leaving the through traffic lanes.

STORAGE - The distance between the right-of-way line, and the vehicle customer service point.

STREET - (See Highway).

TRAFFIC LAND - The portion of the traveled way for the movement of a single line of vehicles.

TRAVELED WAY - The portion of the roadway for the movement of vehicles, exclusive of shoulders and auxiliary lanes.

ZONING - The division of a municipality (or other governmental unit) into districts, and the regulation within those districts of: the height, and bulk of buildings and other structures, the area of a lot which may be occupied, and the size of required open spaces, the density of population, and the use of buildings and land for trade, industry, residence, or other purposes.

APPLICATION REQUIREMENTS

1. No person, firm, corporation, or developer shall construct any entrance, driveway, or approach connecting with any public roadway, nor shall any curb along such roadway be cut, or removed without the written permit of the City Authority, and then only in accordance with the regulations, and requirements contained herein.
2. The City Authority shall determine, and establish such requirements, and restrictions for such private entrances, driveways, and approaches as may be necessary to provide for drainage of roadway, preservation of the roadway, and for the safety, and convenience of traffic on roadway.

3. Such regulations and requirements to facilitate storage may include the minimum distance that gasoline pumps, buildings and other structures, to which such private entrances, driveways or approaches make a connection, may be placed next to the Right-of-Way line of the roadway, or next to the outside edge of sidewalks along these roadways.
4. All work on such private entrances, driveways and approaches shall be done under the supervision and to the satisfaction of the City Authority and the entire expense of constructing such private entrances, driveways and approaches shall be borne by the person, firm, corporation, or developer to whom such permit is given.
5. the City Authority is authorized to require, before granting such permit, that a sufficient bond be given or cash deposit be made with the City Authority to insure the carrying out of the terms of such permit, which bond, or deposit shall be returned when the requirements of the permit have been met.
6. The owners, or occupants of the abutting property shall maintain, and keep in repair all such private entrances, driveways, and approaches shall be constructed or maintained in such a manner as to obstruct or interfere with the roadway, the traffic thereon, or with any drain or ditch which has been constructed on, or which serves such roadway.
7. When any roadway is constructed, or reconstructed the construction of all public road approaches, and existing private approaches together with the drainage structures required for its protection, shall be included as a part of the improvement of roadway. The City Authority may require the changing of the location of any existing drives, in the interest of safety to the motoring public when the roadway is constructed or reconstructed, and such person, firm, corporation, or developer owning or occupying the abutting property shall make such change in location under the direction of the City Authority. Upon the completion of the roadway, the owners or occupants of adjoining lands shall keep in repair all private approaches or driveways from such highways.
8. When there is a change in the type of business and/or land use of an existing property regardless of how slight or minor a new application for a permit must be submitted to the City Authority for approval of existing driveways or changes that may be required.

9. The person, firm, corporation, or developer must obtain a driveway permit before an Improvement Location Permit, and/or Building Permit will be issued.
10. Any person, firm, corporation, or developer violation any of the provisions of this section shall be subject to a fine not to exceed the amount as set forth as a fine for such offense.
11. The expense of relocation or replacement of any and all improvements within the right-of-way shall be the sole responsibility of the permittee.
12. In no case shall vehicles be allowed to stand on any portion of the roadway. It will be the owner's responsibility to close the entrance of the facility before such a condition occurs.
13. No entrance shall be altered, relocated, or remodeled without permission of the City Authority.
14. Construction of entrance and approach shall be completed within 1 year of issuance of such permit. If such construction is not completed then the permit must be reapplied for.
15. The angle of any drive or approach shall be 90° unless otherwise approved by the City Authority.
16. When access is requested to a loading dock then there must be sufficient distance between the dock, and the sidewalk, or right-of-way to prevent encroachment while parking or maneuvering.
17. A performance bond shall be posted to insure compliance with the terms of the permit, at the discretion of the Traffic Engineer.
18. Liability insurance must be furnished according to the City Authority requirements.
19. The City Authority reserves the right to remove or barricade non-conforming access installations.

APPLICATION - DRAWINGS AND INFORMATION REQUIRED: All applications for permits under these regulations shall be accompanied by clear drawings. One (1) drawing to accompany each application form. Information to be shown on drawings, which shall include a plot plan, to scale, of the entire tract of land as recorded in the office of the County recorder, and properly dimensioned indication the proposed improvements, location, and intended use. Said plot plan, or additional attached detailed plans, to scale, depict the

following:

1. Property lines.
2. Right-of-way lines, and width.
3. Nearest intersecting roads, and streets or railroads on either side of proposed driveway.
4. Width, and type of road surface.
5. Necessary, and existing pipe, tile, or other drains, stating size, and kind.
6. Existing utilities.
7. Proposed, and existing driveways, and approaches.
8. Distance from right-of-way lines to proposed, and existing structures including gasoline pumps, signs, barriers, landscaping, etc.
9. Proposed type of surface, and width of driveways.
10. Proposed type of surface, and width of approaches.
11. Proposed type surface, length, and width of recovery, and deceleration lanes if required.
12. Proposed radii.
13. Proposed treatment of right-of-way area adjacent to, and between approaches.
14. Proposed rate of slope, or grade, of approaches, and driveways.
15. Proposed internal parking details. Class III and IV entrance permit applications shall include a plot plan with all pertinent topography to scale, and properly dimensioned for at least 150 feet in each direction of property, and on both sides of all roadway affected; i.e., all existing driveway entrances, approaches, and crossovers in the case of a median. Class I, II, and V entrance permit applications shall include to reasonable scale and reasonable dimension all adjacent property in each direction of property requiring access and on both sides of all roadway affected all existing driveway entrance, approaches and in the case of a median the crossovers.

TEMPORARY PERMITS

The issuance of a Temporary Permit for the construction of access driveways will be considered under the following circumstances.

1. Existing facilities which have been designated "Limited Access Controlled Highways", or,
2. Existing highways with normal access control which are scheduled for improvement.

The designation of an existing highway as a Limited Access Control Facility has brought about special problems as related to the issuance of permits, for access driveways. This is especially true where the actual implementation of limited access control features is delayed for some period of time after the designation order, and no program for acquiring access rights has been undertaken.

There are many cases under these conditions where a property owner abutting a facility which has been designated a "Limited Access Controlled Highway" is considering the development of commercial property. In some circumstances, the property owner or developer, might be willing to risk obtaining a considerable return on his investment if he could have direct access to the highway during the period in which plans are being developed, and right-of-way obtained for physical conversion to "Limited Access Control" status. Under these, and similar circumstances, and if in compliance with the regulations of the Responsible Authority temporary access permits for the construction of driveways may be granted abutting owners, provided the proposed improvement to the property do not increase the cost of acquiring right-of-way and access rights.

The granting of temporary access permits for access to designated "Limited Access Control Highways", and to Highways and Streets with normal control of access scheduled for improvement, will be considered where such permits will be accepted by the owner or developer with the inclusion of a suitable clause protecting the Responsible Authority against improvement costs. First, such permits should be prominently labeled "Temporary Driveway Permit":. The permit should then contain a paragraph worded essentially as follows:

The applicant hereby states that he is the owner of record of the tract of land to be served by the access driveway described herein, said land being situated in the City of Lafayette, County of Tippecanoe, State of Indiana. [Description of property here] The applicant understands

that the above described driveway is within the limits of designated limited access control or limits of existing or proposed public right-of-way, and that such entrance will be removed or revised at such time that the Responsible Authority completes negotiations for access rights to the property or right-of-way. It is further understood that the applicant will not claim additional damages because of the existence of the driveway described herein. It is also understood that this permit is accepted with the full understanding that any improvement or construction on the property after [date] shall not be considered as increasing the value of the rights of access of right-of-way at such time as these rights are obtained for the purpose of developing the adjacent facility. It is also understood that this permit will expire, and may be renewed within one year from date of issue or upon negotiation of right-of-way, whichever, is "latest".

Since temporary permits of this sort will have a direct bearing on the acquisition of access rights and right-of-way in the future, they are to be recorded in the deed or abstract and duly recorded with the proper agency. In case the property under permit changes ownership before the facility is physically converted to a limited access control facility, or improved, as the case may be, a recorded permit will be more effective in maintaining the rights of the Responsible Authority as noted in the application. The same standards, and criteria shall govern temporary driveway permits as previously outlined for all driveways to highway facilities.

CLASSES OF DRIVEWAY ENTRANCES

All entrances from highway or street to public, or private property shall be generally classified as follows, and a permit shall be required.

Class I - Residential Entrance - A driveway by which a street with a raised curb but only shoulders, is connected to a one- or two-family and is ordinarily used only by the owner or occupant of the premises, such as a garage, barn, residence, or other improved property.

Class II - Residential Entrance - A driveway by which a street without a raised curb but only shoulders, is connected to a one- or two-family residential facility, and is ordinarily used only by the owner or occupant of the premises such as a garage, barn, residence, or other improved property.

Class III - Commercial Entrance - A driveway, or driveways, by which a street with raised curb is connected to public, or private property which is multi-residential, commercial, industrial, school, or church in nature.

Class IV - Commercial Entrance - A driveway, or driveways by which a street without a raised curb but only shoulder, is connected to public or private property which is multi-residential, commercial, industrial, school or church in nature.

Class V - Private Entrance - A driveway connecting a street with unimproved property that is not used commercially, such as fields, or vacant lots.

GENERAL SPECIFICATIONS

CLASS	Maximum Driveway Width	Divided Entrance	Recommended Entrances per Street	Approach Pavement Required
I	16	NO	1	NO
II	16	NO	1	NO
III	30	YES	2	YES*
IV	30	YES	2	YES*
V	20	NO	1	NO

* Approach pavements may be required as specified herein, or as required by Responsible Authority.

CLASS I, CLASS II, AND CLASS V ENTRANCES FOR RESIDENTIAL, PRIVATE GARAGES, AND OTHER IMPROVED AND UNIMPROVED PROPERTIES.

GENERAL REQUIREMENTS:

1. The application shall be accompanied by a plot plan properly dimensioned, showing all existing driveway entrances, approaches, and other pertinent features.
2. Common driveways for adjacent property owners are encouraged provided a written agreement between the property owners is properly documented.
3. The location of driveways shall be such that no part of the radius shall extend beyond the extension of the adjacent property line, unless a written agreement is obtained from the adjacent property owner.
4. Drive approach surfaces shall be of a type acceptable to the Responsible Authority; but in any case, it shall be of a material similar to the adjacent roadway.
5. All access geometrics, such as entrance, location, driveway width shall be in accordance with the [figures provided].

CLASS III AND CLASS IV ENTRANCES
FOR MULTI-RESIDENTIAL, COMMERCIAL, INDUSTRIAL,
SCHOOL AND CHURCH PROPERTIES

A. GENERAL REQUIREMENTS:

1. No application for access to a public street or highway will be considered until all facilities within the development have been agreed upon. A completed site plan showing proposed use, improvements and layout of parking spaces shall be submitted to the Responsible Authority.
2. The application shall be accompanied by a plot plan, and site plan (Minimum Scale 1" = 50') properly dimensioned, showing all existing driveway entrances, approaches, and other pertinent planimetric and topographic features, for distance equal to the sight distance as shown in [table provided].
3. All access geometrics (minimum scale 1":50'), such as entrance location, driveway spacing and width, deceleration, recovery and passing lanes, shall be in accordance with the [figures provided].
4. It will be the responsibility of the Permittee to construct any, and all improvements as set forth by the approval application at the time of the entrance construction.

B. SPECIAL REQUIREMENTS:

1. Two entrances - may be permitted with a minimum of 150 feet frontage, based on anticipated traffic generation provided the distance from any driveway approach to an adjacent property line, or alley way is a minimum of ten (10') feet. Minimum distance between drives shall be twenty (20') feet.
2. Divided entrance - may be required for major traffic generators. The Responsible Authority reserves the right to permit or require a divided entrance, based on the parking capacity of the establishment and the effect on the traffic service of the adjacent highway. Driveways shall be operated in a one-way pattern. Additionally the length of the median, and barrier curb along the right edge of entrance should be of sufficient length to preclude the internal conflicts within the parking lot causing interference with traffic on the roadway.

3. Entrances for Use Primarily by Tractor-Trailer Combinations - may be permitted by the Responsible Authority. Wheel path templates shall be used to determine geometric design.
4. Traffic Control Signals - If warranted, shall be in accordance with current standards. Signals installed at entrances, or exits, directly to, or from, the development will be installed, and power furnished in compliance with the "Industrial and Commercial Signal Policy" and in accordance with the terms of the permit. Subsequent to installation, all traffic control signals will be operated, maintained, and be the property of the Industry of commercial establishment requesting signal. The Responsible Authority shall determine the need for signal control, and the design, and type of signal to be installed. The Responsible Authority shall regulate the timing, and synchronization of the signals. A Signed Agreement between the Permittee, and the Responsible Authority will be required.
5. Median crossovers on divided highways will not be permitted unless the spacing is in conformance with dimension "P" as indicated on [drawing provided].

C. DESIGN DETAILS:

1. For establishments, or development with high turn-over rates, and limited parking area (drive-in restaurants, drug stores, grocery stores, etc.) the parking spaces shall be laid out in such a manner as to preclude entering vehicles from interfering with traffic on the roadway.
2. The near edge of the driveway shall be a minimum of 50 feet, or 25 percent of the frontage, whichever is greater, from the existing, or future proposed right-of-way line (extended) of the intersecting street. (See [drawing provided].)
3. The capacity, and storage requirements of the subject intersection shall be checked by Responsible Authority based on a projection of the existing traffic for a period of ten (10) years, and if the indicated minimum dimensions are below storage requirements, they shall be increased accordingly.
4. The Permittee shall be responsible for any curbs, pavements, widening, deceleration lanes, recovery lanes, islands, or drainage structure

required. All construction shall be of a structural design, and type acceptable to the agency responsible for the adjacent public roadway.

5. No part of the driveway entrance may extend beyond a line extended perpendicularly from the roadway centerline to the point of intersection of the property line and right-of-way without the written permission of the adjacent property owner.
6. When the parking, or driving area, of a property is adjacent to a sidewalk, or an alley, then a suitable non-mountable barrier must be constructed to prevent encroachment.

CLASS III AND CLASS IV ENTRANCES
FOR GASOLINE SERVICE STATIONS

A. GENERAL REQUIREMENTS

1. No application for access to a public street or highway will be considered until all facilities within the development have been agreed upon. A completed site plan showing improvements, and layout shall be submitted to the Responsible Authority.
2. The application shall be accompanied by a plot plan (Minimum Scale 1" = 50') properly dimensioned, showing all existing driveway entrances, approaches, and other pertinent planimetric, and topographic features, for a distance equal to the sight distance as shown in the [table provided].
3. All access geometrics, such as entrance location, driveway spacing, and width; deceleration, recovery, and passing lanes; shall be in accordance with the [figures provided].
4. No service station entrance will be permitted on any corner lot which has a frontage of 100 feet or less.

B. SPECIAL REQUIREMENTS:

1. Two entrances - may be permitted with a minimum of 150 foot frontage, based on anticipated traffic generation provided the distance from any driveway approach to an adjacent property line, or alley way is a minimum of ten (10') feet. Minimum distance between drives shall be twenty (20') feet.

2. Multiple Land Use Complexes - will be considered as a single site. Service stations constructed, or to be constructed, as an integral part of such a complex will not receive separate consideration for an entrance.
3. Median Crossovers on Divided Highways - will not be permitted unless the spacing is in conformance with Dimension "P" as indicated on [drawing provided].

C. DESIGN DETAILS:

1. No part of the driveway entrance may extend beyond a line extended perpendicularly from the roadway centerline to the point of intersection of the property line, and right-of-way line without the written permission of the adjacent property owner.
2. A tangent line projected from the end of the approach curb radius must be parallel to the center line of the road.
3. The permittee shall be responsible for any curbs, pavement widening, deceleration lanes, recovery lanes, islands, or drainage structure required. All construction shall be of a structural design and type acceptable to the agency responsible for the adjacent public roadway.
4. All pump islands must be located a minimum of ten (10') feet from the right-of-way line, or as required by the State Fire Marshall.
5. The near edge of the driveway shall be a minimum of 50 feet or 25 percent of the frontage, whichever is greater, from the existing or future proposed right-of-way line (extended) of the intersecting street. (See [drawing provided].)
6. When the parking, or driving area, of a property is adjacent to a sidewalk, or an alley, then a suitable non-mountable barrier must be constructed to prevent encroachment.

CLASS III AND CLASS IV ENTRANCES
FOR CAR WASHES AND DRIVE-IN BUSINESS

A. GENERAL REQUIREMENTS:

1. No application for access to a public street, or highway will be considered until all facilities

within the development have been agreed upon. A completed site plan showing improvements, and layout, shall be submitted to the Responsible Authority.

2. The application shall be accompanied by a plot plan (Minimum Scale 1" = 50') properly dimensioned, showing all existing driveway entrances, approaches, and other pertinent planimetric and topographic features, for a distance equal to the sight distance as shown in [table provided].
3. All access geometrics, such as: entrance location, driveway spacing and width; deceleration, recovery and passing lanes; shall be in accordance with the [figures provided].

B. SPECIAL REQUIREMENTS:

1. Two entrances - may be permitted with a minimum of 150 foot frontage based on anticipated traffic generation provided the distance from any driveway approach to an adjacent property line, or alleyway is a minimum of ten (10') feet.
2. Divided Entrance - may be required for major traffic generators, the Responsible Authority reserves the right to permit, or require a divided entrance, based on the parking capacity of the establishment, and the effect on the traffic service of the adjacent highway.
3. Additionally, the length of the median, and barrier curb along the right edge of entrance should be of sufficient length to preclude the internal conflicts within the parking lot causing interference with traffic on the roadway.
4. Median Crossovers on Divided Highways - will not be permitted unless the spacing is in conformance with Dimension "P" as indicated on [drawing provided].
5. In no case shall vehicles be allowed to stand on any portion of the roadway. It will be the owner's responsibility to close the entrance of the facility before such a condition occurs.

C. DESIGN DETAILS:

1. Car Washes

- a. A car wash shall be designed to permit storage of vehicles within the facility equal to 100 percent of the anticipated peak hour capacity. In units having more than 1 bay, the following table shall be used.

Number of Bays	Storage Requirements* per Bay
1	100 percent
2	90 percent
3	80 percent
4	80 percent

Percentage of total peak hour capacity. The storage length for each vehicle shall be 22 feet.

- b. The exit distance for each bay shall be a minimum of 50 feet from the right-of-way line.

2. Drive-In Banks shall be designed in accordance with the following table:

No. of Drive-In Windows	Required Storage Vehicles	Distance per Window
2	10	220 feet
3	7	154
4	4	110
5	4	88
6	4	88
7	3	66
8	3	66
9	2	44

3. Design details for other types of drive-in businesses will be based on their specific use. Storage requirements will be based on a review of peak hour capacity.
4. The near edge of the driveway shall be a minimum of 50 feet or 25 percent of the frontage, whichever is greater, from the existing or future proposed right-of-way line (extended) of the intersecting street. (See [drawing provided].)
5. The capacity and storage requirements of the subject intersection shall be checked, based on a projection of the existing traffic for a period of ten (10) years,

and if the indicated minimum dimensions are below storage requirements, they shall be increased accordingly.

6. The permittee shall be responsible for any curbings, pavement widening, recovery lanes, deceleration lanes, islands, or drainage structure required. All construction shall be of a structural design, and type acceptable to the agency responsible for the adjacent public roadway.
7. No part of the improvement may extend beyond the extension of the adjacent property line without the written permission of the adjacent property owner.
8. When the parking, or driving area of a property is adjacent to a sidewalk, or an alley, then a suitable non-mountable barrier must be constructed to prevent encroachment.

SIGHT DISTANCE REQUIREMENTS TABLE

<u>MPH*</u>	<u>DISTANCE</u>
20	150'
30	200'
40	300'
50	450'

*Based on Posted Speed Limits.